MACHINERY

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ADJUSTABLE AND MULTI-CUTTING TURNING TOOLS

DESIGN AND APPLICATION FOR THE TURRET LATHE AND BORING MILL

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THE cost of tool equipment for the manufacture of interchangeable work is an item which should be proportionate to the number of pieces to be machined. The saving in time which can be made by the use of special tools should also be carefully considered, as there are many cases where special equipments are designed for work which could be handled to advantage by the judicious use of standard tools. In order to obtain the greatest possible production from their machines, there have been instances where machine tool builders have sold tool equipments of expensive design, when a standard equipment would have done the work very nearly as well. Undoubtedly there was some gain in production, but it is doubtful whether the saving in time would pay for the special tools. The upkeep of special tools is also a factor which must be taken into consideration. It is interesting to note that the present aim of machine tool builders is to so design standard tool equipments that they can be adapted readily to a great variety of working conditions. A great deal of time is spent by manufacturers in devising and experimenting with various tools in order to perfect them to such an extent that they will conform to these conditions.

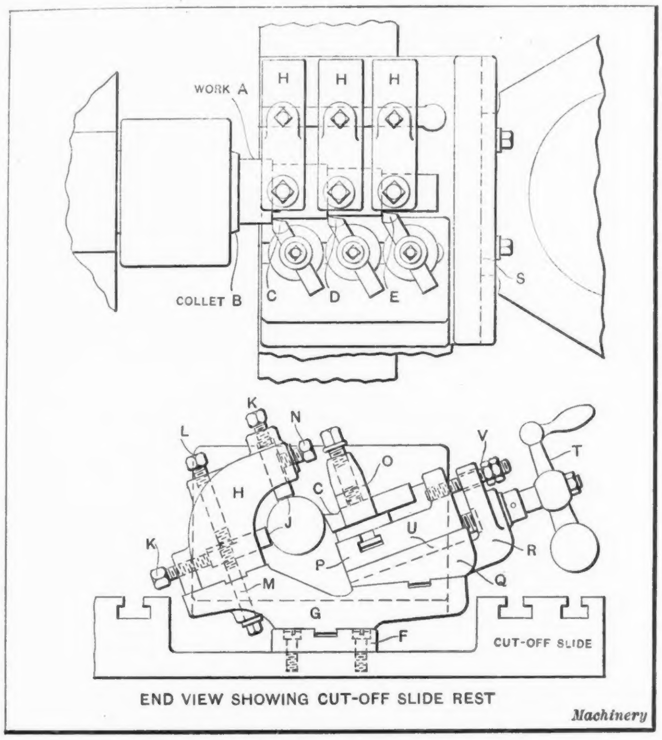

Fig. 1. Special Multi-turning Tool for Bar Work

The rapid growth of the automobile industry in the past ten years is largely responsible for the broader development of our machine tools. The enormous quantities of interchangeable parts which are required in this industry and the manufacturers' desire for increased production have brought into existence a great variety of multi-cutting tools. Tools of this kind may be designed for a variety of uses, and tool-holders capable of containing several tools can also be designed to handle a considerable range of work.

Adjustable tools and those having cutters for turning several diameters are sometimes combined with boring-bars, drills, or cutter heads, these being applied to some one of the various types of turret lathes. They are also occasionally designed for use on a vertical boring mill.

When used on the turret lathe, the cut-off slide is frequently equipped with a gang of tools so that the operations of turning, boring and facing can be carried on at the same time. Quite frequently the tools are so arranged that from nine to twelve are working at the same time, with the result that there is a considerable gain in production. There are a great many varieties of so-called "box-tools" on the market, and these are principally used for bar work on turret lathes or screw machines having a collet mechanism. Tools of this type are usually a part of the standard equipment furnished with screw machines adapted to bar work, and they will not be discussed in the present article.

The design of multi-cutting turning tools for castings and forgings which have several diameters to be machined, is a subject well worth considering, for it is safe to say that nearly any manufacturer who uses horizontal or vertical turret lathes can greatly increase the productive efficiency of his machines by the judicious use of multi-cutting tools. The several designs of turning tools illustrated in this article have been built for various purposes, and a careful study of the types shown may be of assistance in suggesting methods which can be used to perform some piece of work requiring tools of a similar kind. Some of the important points in the design of tools of this nature are given herewith.

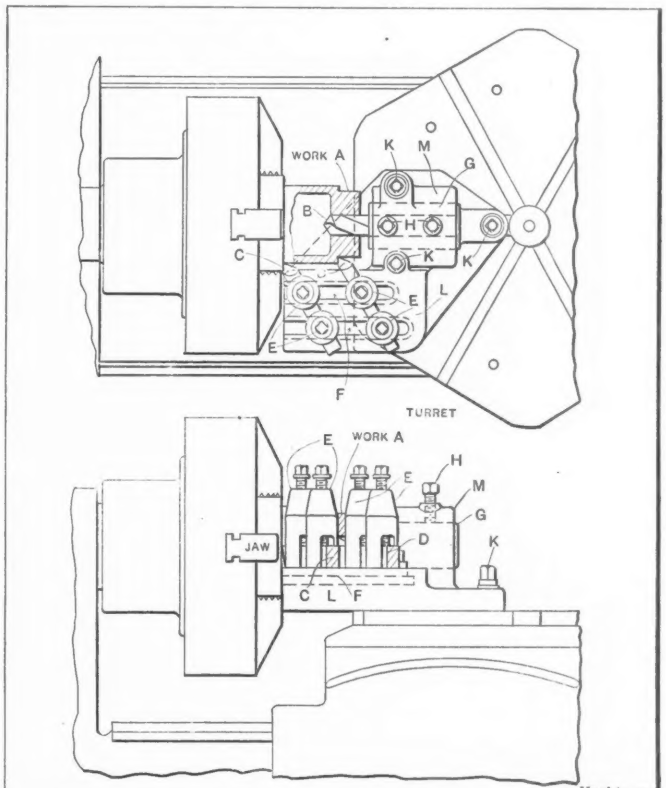

Fig. 2. Multiple Tool-holder for the Turntable Type of Lathe

General Points in Design

1. Rigidity: Avoid overhang as much as possible unless some sort of outboard support can be used. Pilot the tool if practicable.

2. Arrangement of tools: They should be perpendicular to the plane in which the turret rotates when indexing, be-

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cause variations in diameters are less likely to take place when tools are arranged in this way. Unequal indexing of the turret has very little effect on the radial position of the tools under these conditions, so that sizes can be held much closer than if they are placed in a plane parallel to the turret rotation. Use standard rectangular stock for the cutting tools so that the upkeep will be inexpensive and reforging be avoided.

3. Try to make the block containing the tools removable so that it can be replaced easily by another block with tools arranged differently to handle other work.

4. Make the tool-block adjustable if possible.

5. Back up the tools with adjusting screws.

6. See that provision is made so that cutting lubricant can be directed on the faces of the tools when forgings or steel castings are to be machined.

7. Arrange the tool-block in such a way that the thrust of the cut does not come against it; it is much better to have the thrust come on the body of the tool.

Multi-turning Tool for Electric Motor Shafts

One example shown in Fig. 1 is given of a multi-turning tool for bar work. This tool was designed for use on the

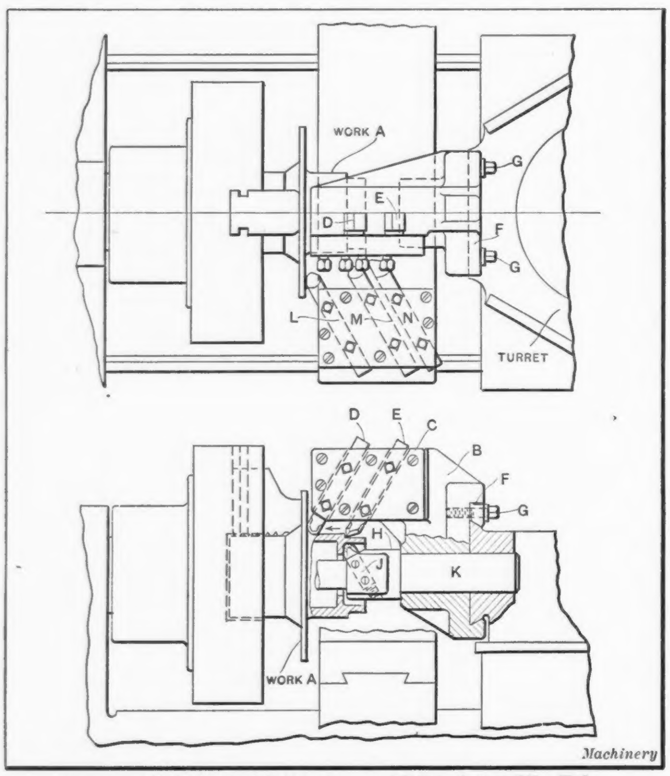

Fig. 3. Multiple Tool-holder for machining Automobile Hubs

electric motor shaft shown at *A* in the illustration. The work was handled in short lengths although the stock is a regular commercial product. Roughing and finishing operations were performed with the same type of tool. The work was held in collet jaws. Something like twenty varieties of shafts having different diameters and shoulder lengths were handled by these tools.

A Pratt & Whitney turret lathe with collet mechanism was used for this work; as this type of machine has a turret with dovetail faces, the body of the tool *G* was arranged to fit the dovetail and the gib *S* held it in place. The cut-off slide was planed off at the center and the hardened steel block *F* was secured to it. It will be noted that this block acts as a support for the tool, and the tongue assists in preventing lateral movement. The cast-iron block *Q* is fastened to the body of the tool and it is dovetailed at *U* to receive the tool-slide *P*. This is of steel and it is T-slotted so that standard toolposts *O* can be used. It will be seen that the tools *C*, *D*, and *E* are held in such a way that they can be adjusted readily both for different diameters and for shoulders of varying lengths. The slide is screw controlled and is operated by the handle *T*. A positive adjustable stop is provided by the check-nuts *V*. The back-rests *J* are of tool steel and are contained in the brackets *H*. The screws *K*, *L*, and *N*, are used for binding and adjusting, while those at *M* pass down through slots in the body of the tool and permit adjustment of the back-rests in a longitudinal direction.

Points worthy of notice in this tool are the method of supporting the body by means of the block on the cut-off slide, the flexibility of the tool adjustments, and the ease with which any tool may be replaced if broken or used up. The

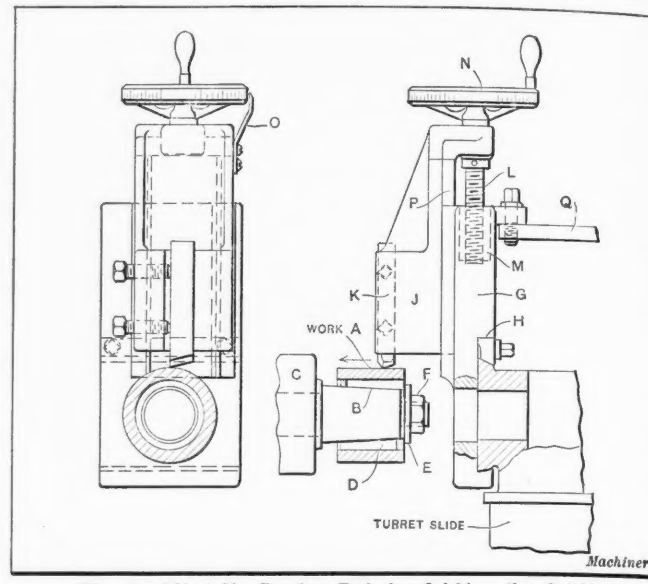

Fig. 4. Adjustable Turning Tool for finishing the Outside of Short Bushings

tools are of standard section and therefore require no machining except cutting off and grinding.

Multiple Tool-holder for the Turntable Type of Lathe

The bronze nut shown at *A* in Fig. 2 is an example of a piece of work which is to be drilled and turned on two diameters at the same time. There were six pieces of this kind varying slightly in size, which had to be machined in lots of twenty-five. Two tool-holders were used to do the work, one tool being arranged as shown in the illustration,

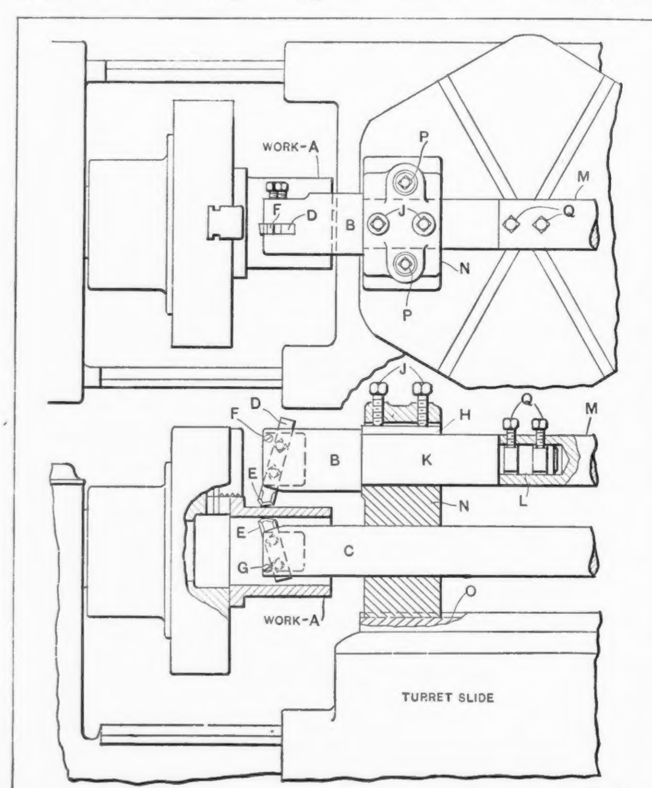

Fig. 5. Boring-bars for turning Concentric Packing Rings

while the other contained a boring tool in place of the drill *B*. The holder *L* was made of cast steel and was T-slotted in two places at *F*, so that tool-holders *E* of the standard type could be used. These carry the tools *C* and *D*, and attention is called to the way in which two posts are used for each

tool to insure the maximum rigidity. The body of the holder is fastened to the turret face by the screws *K*, and is tongued on its under side to fit the slot. A semi-cylindrical boss *M* contains the split bushing *G* which holds the drill *B*. Two screws *H* are employed to clamp the bushing. This holder is simple, easily made and quite adaptable for work within its capacity. There are likely to be slight variations in the diameters turned due to imperfect indexing of the turret, but for general commercial work these usually are not great enough to cause any serious trouble.

Multiple Tool-holder for an Automobile Hub

The piece of work shown at *A* in Fig. 3 is an automobile hub, and the tool-holder is arranged so that the operations of turning and boring can be carried on simultaneously with the facing. The tools *L*, *M* and *N* are secured in a special block on the cut-off slide. The tool-holder *B* is of cast iron and well ribbed; it fits the dovetailed face of the turret, being secured in position by the screws *G* and the gib *F*. The turning tools *D* and *E* are mounted vertically, and the steel cap-plate *C* contains the necessary holding screws. The boring-bar *H* is piloted in a chuck bushing at its forward end and contains the tool *J*, which stands in a vertical plane like the turning tools. The shank of the bar *K* is secured by the turret binding screw and an additional set-screw in the holder itself. A tool of this type will produce more accurate work than the type shown in the preceding illustration, on account of the position of the cutting tools with reference to the turret indexing. A feature of some importance is the piloting of the boring-bar, as this assists in the prevention of vibration. Care should be taken in the design of tool-holders of this type, that the overhang from the turret face is not too great, for if this is excessive, a certain amount of chatter is inevitable.

Adjustable Turning Tool for Short Bushings

A number of short bushings such as that shown at *A* in Fig. 4 were to be refinished on the outside. The bushings were of various diameters ranging from 2¼ to 4 inches, while the lengths varied from 1½ to 3 inches. The pieces were held on arbors *B*, in collet jaws *C*. A split sleeve *D* was expanded inside the work by the action of collar *E* and nut *F*. The body of the tool *G* was secured to the dovetailed face of the turret by gib *H*. The tool-slide *J* is a steel casting dovetailed at *P* and fitted with an adjustable taper gib to take up the wear. The cutting tool *K* is placed in a slot in the slide and is secured by the screws shown. The screw *L* is journaled in a lug at the upper end of the slide and enters a steel nut *M* in the body of the tool. Radial adjustment is obtained through this screw by means of the handwheel *N*. The rim of the wheel is graduated and the pointer *O* permits accurate readings to be made. This tool is very good indeed for light work, and accurate results can be obtained by its use. When two tools are used, a tie-rod *Q* assists in making the combination more rigid.

Holder for Adjustable Boring- and Turning-bars

The work shown at *A* in Fig. 5 is a cast-iron pot from which concentric packing rings are to be cut, and the boring and turning are done at the same time. Two cast-iron holders *N* are tongued at *O* and secured to opposite sides of the turret by the screws *P*. The turning- and boring-bars *B* and *C* pass through the holders and extend entirely across the turret. The boring-bar *C* is of the same diameter along its entire length, and it is secured in the holders by shoe binders similar to that shown at *H* but located in the sides of the holders. The boring tools *E* are of rectangular section and secured by set-screws in the slots at the ends of the bar. The screws *F* and *G* help to stiffen the ends of the bars where they are slotted. The upper or turning-bar is made in two sections *K* and *M* so that the tools may be swung radially to bring them into their proper position when the turret is set off center for turning larger diameters. The end of one bar is turned down at *L* to fit the hole in the other bar and the screws *Q* make a firm joint. A set of bars and holders of this kind is a very useful adjunct to a turret lathe equipment, and it may be adapted to a variety of uses. The double tie feature across the turret gives exceptional rigidity.

Piloted Multiple Turning Tool for Steel Gear Blanks

The automobile jack-shaft gear blank shown at *A* in Fig. 6 is of alloy steel and it is held in special chuck jaws so that it can be drilled, turned and faced simultaneously. A special tool-block on the cut-off slide performs the latter operation, while the turning and drilling tools are carried by the turret. The body of the turning tool *V* is made of cast iron and is fastened to the dovetail turret face by the gib shown at *U*. The tool-block *K* is of steel and is slotted to receive tools *M* and *N*. An oil groove is cut at *L* along the top of the block and it is supplied with oil from the special piping system shown. The pipe *S* leads to the distributing collar *T* which, in turn, is connected with the cutting lubricant piping system on the machine. The slots in the tool-block are of sufficient width to permit an ample supply of fluid to run down and

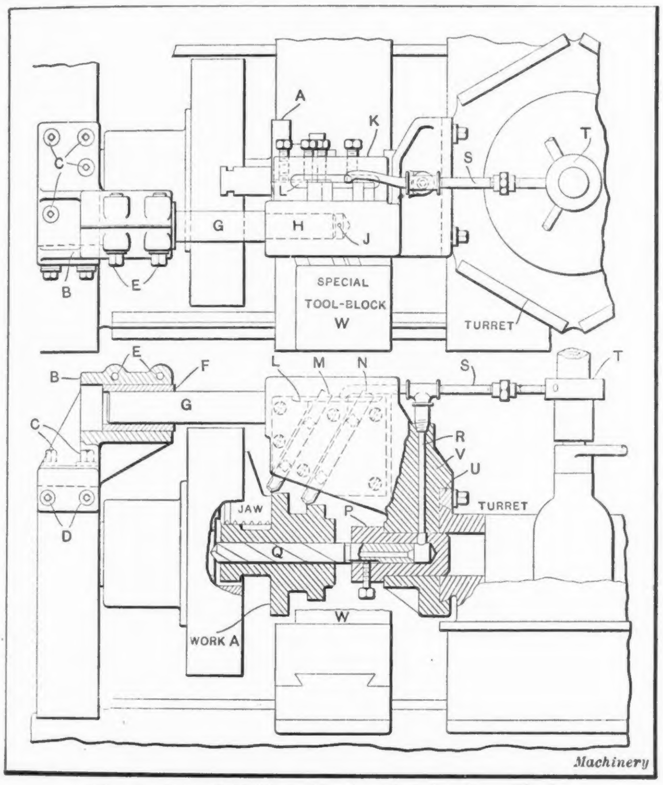

Fig. 6. Piloted Multiple Turning Tool for Gear Blanks

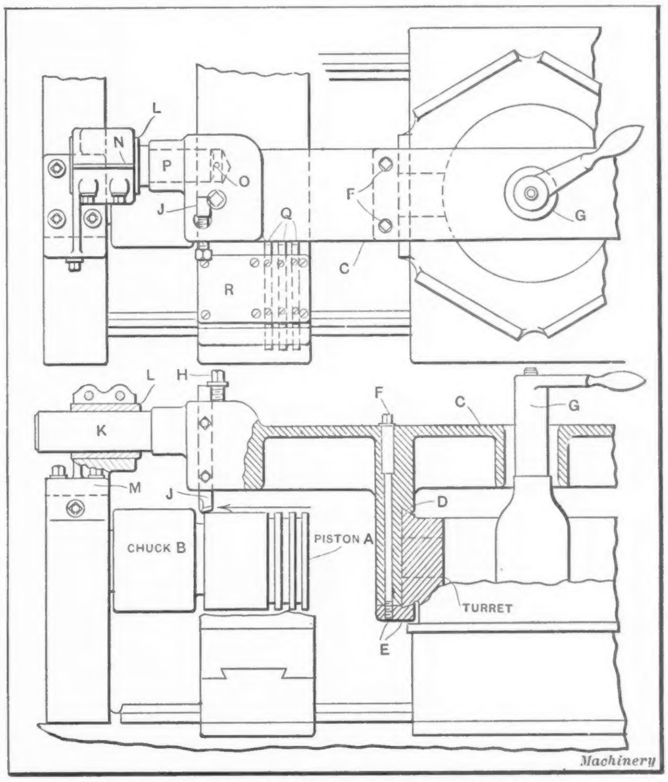

Fig. 7. Double-end Piloted Turning Tool for Pistons

reach the cutting ends of the tools, thus assisting greatly in prolonging the life of the tools and also allowing higher cutting speeds. The oil-drill Q is held in a steel supporting bushing P which fits the body of the tool-holder. It is supplied with lubricant through the hole R which is connected to the piping system. The steel pilot G is shouldered at H and is forced into the body of the holder. The small hole J is put in so that air pressure will not be generated when the pilot is pressed into place, as this would tend to deceive the fitter by making him think he had a good fit when, in reality, it was compressed air that made the pilot hard to force in. I have seen pilots fitted so that they were apparently all right at the time when the work was done, and yet when the time came for the tools to be used, it was found that they were loose enough to cause trouble. The air hole will prevent trouble of this kind.

A special bracket is shown at B and it is screwed to the spindle cap by the screws C and D. The bronze bushing F receives the end of pilot G, and it is clamped by the binding screws E. This method of supporting a turning tool is very successful and assists greatly in permitting heavy cutting without chatter. Another feature of this tool is the manner in which oil is conveyed to the cutting tools. Attention is also called to the position of the tool-block, this being at the rear of the body so that the thrust of the cut is brought directly against the heavier part of the casting. The method of mounting the tools is also a little out of the ordinary, in that the block and tools form a unit which can readily be removed, permitting the substitution of another block with tools arranged differently, to handle other work requiring different spacing. Two turning tools on opposite sides of the turret were used for this particular piece, one being used for roughing and the other for finishing.

Double-end Piloted Turning Tool for Pistons

The piston A shown in Fig. 7 is held by the inside on a special expanding pin chuck B. The arrangement of tools is that recommended by the Pratt & Whitney Co., for turning automobile pistons on their horizontal turret lathe. The turning tool-holder C is of cast iron and is double ended, reaching entirely across the turret, and the two ends are exactly the same. The body or arm is of U-section and it is cored out at the center so that the turret binder-lever can pass through it, as shown at G. A careful fit is made on the dovetail at D, and two special bolts F pass down through the body of the tool and pull up the gib E against the lower dovetail, thus clamping the tool securely. The tool J is backed up by the collar-head screw H and is secured by means of two screws. The steel pilot K fits the bushing L in the spindle cap bracket M, as in a previous instance. It will be noted that an air hole O is provided where the shank P enters the end of the tool body. In connection with the turning tools a special block on the cut-off slide is used to cut the ring groove in the piston. This block and tools are shown at R and Q in the upper view. This style of equipment is very well known and has given universal satisfaction.

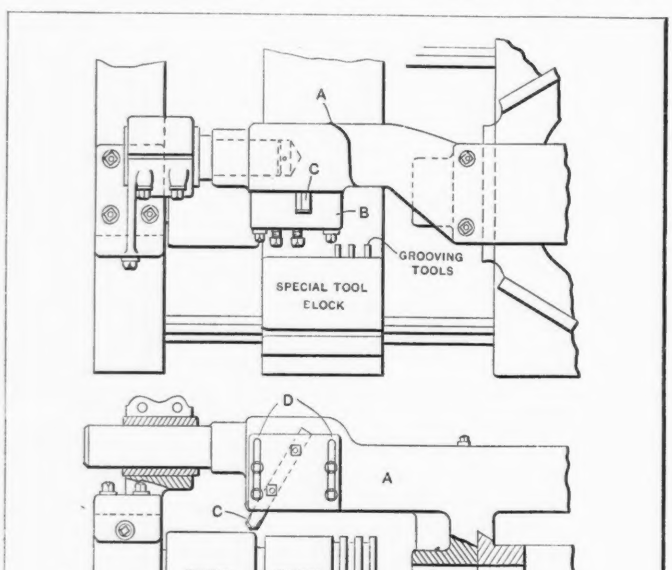

Fig. 8. Piston Turning Tool having Adjustable Tool-block

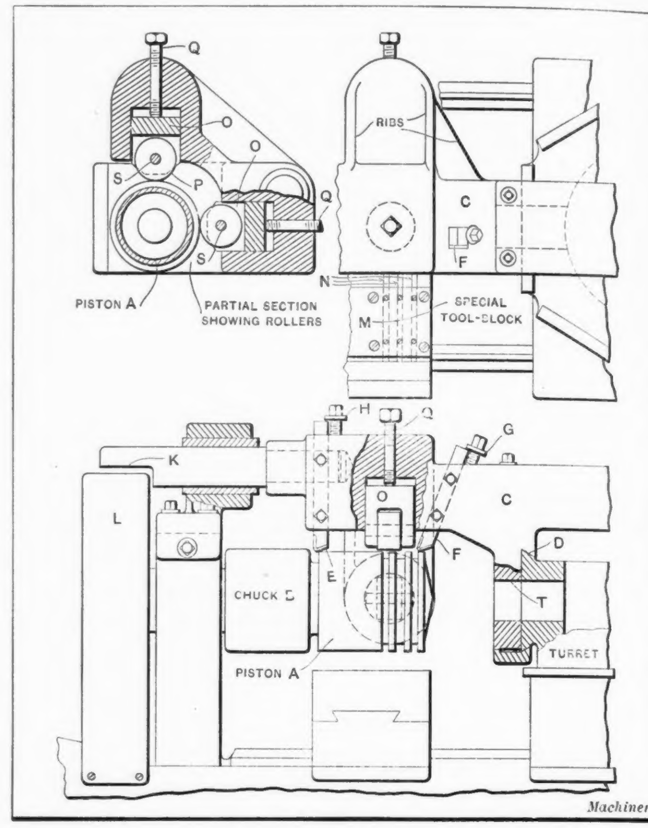

Fig. 9. Multiple Turning Tool equipped with Pilot and Roller Back-rest

Piston Turning Tool having Adjustable Tool-block

A development of the preceding tool is shown in Fig. 8. It will be noted that although the general construction is about the same, in this instance the tool-block is made separate so that other blocks may be substituted having more than one tool. Considerable adjustment is also permissible by means of slots shown at D. It is obvious that this method of construction requires the tool-block B to be of steel and somewhat heavy, so that it will properly resist the thrust of the cut. The screws which hold the block in position must also be of ample size. As this particular tool was designed for use in turning and boring ring pots, in addition to piston work, the boss E was supplied and bored at F to receive a boring-bar.

Special Multiple Turning Tool with Roller Back-rest

In a great many instances the design of an automobile piston is such that it is permissible to center the solid end, and this gives a chance to support the end by a conical rest. While the ring grooves are being cut some support is essential, and in the case of the piston shown in Fig. 9 the use of roller supports in place of a center rest was found necessary for the reason that centering was not permitted. The piston A is held on the special chuck B and the two tools E and F are held in a double-end tool-holder. Adjustment is obtained by means of the collar-head screws H and G. The turning tool body C fits the turret dovetail at D and it is clamped, as previously stated. The end of the pilot K is cut away on its under side in order to clear the gear guard L. The steel supports O are backed up by the screws Q, which are also used for adjusting purposes. The hardened and ground steel rollers P are hung on the pins S. (See detail view.) A special tool-block M contains the grooving tools N. This equipment also was very successful.

Adjustable Piloted Turning Tool for Large Diameters

A somewhat different type of tool is shown in Fig. 10, this being adjustable for various diameters from the 12-inch casting *A* down to a diameter of 6 inches or a trifle under that size if necessary. This tool was rather heavy and cumbersome and not entirely successful on heavy cuts. On the lighter variety of work, however, it proved satisfactory and adaptable. Two tools were used on opposite sides of the turret; the flat steel tie-bar *L* helped to prevent sagging.

The body of the holder *B* is of cast iron cored out so that the walls are ½ inch section, and it is tongued along its lower face to fit the turret at *M*. The forward end holds the steel pilot *C*, which is supported and guided by the bushing *D*. The bracket *E* is fastened to the head of the machine by the screws *F*, thus insuring a rigid support for the end of the pilot. The tool-slide *N* contains the tool *O* and it is securely gibbed by the two steel straps *P*. A taper gib (not shown) provides adjustment for wear on the sides. The bracket *K* is screwed to the top of the tool body and journals the operating screw *H*. A graduated collar permits accurate settings to be made without trouble. A bronze nut in the body of the slide at *J* receives the operating screw.

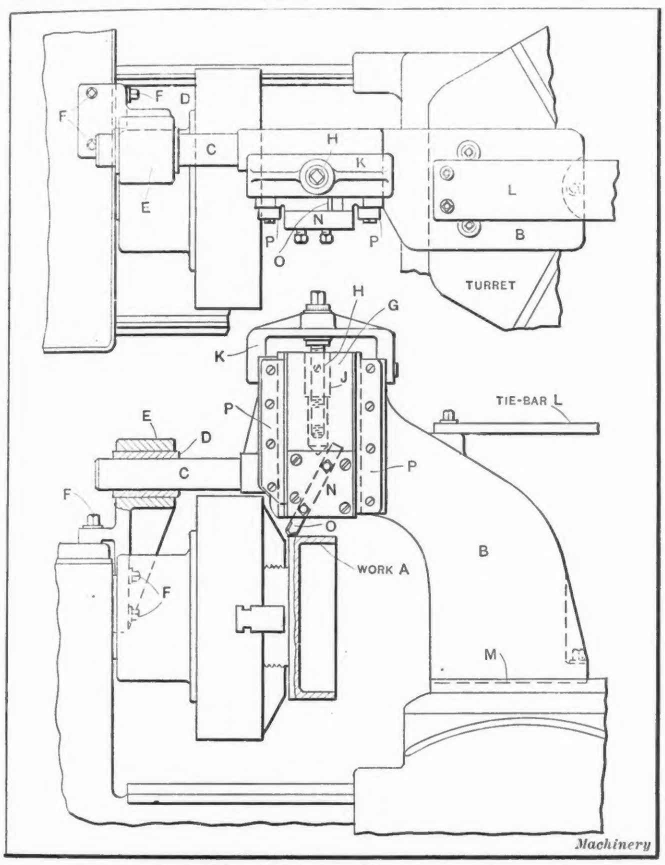

Fig. 10. Adjustable Piloted Turning Tool for Large Work

Multiple Turning Tool for the Vertical Turret Lathe

The vertical turret lathe is less frequently supplied with multiple tools than the horizontal type of machine, for the reason that the regular equipment supplied by the manufacturers is adapted to a wide range of conditions without very much special tooling, and, in addition, the class of work for which this machine is more likely to be used is of such a nature that multiple turning tools are less likely to be required. There are instances, however, when a considerable increase in production may be made by the use of the multiple type of tools. Take for example the special gear shown at *A* in Fig. 11. This piece of work is held by the inside of the rim in special jaws, and the tools in the side-head turret are used to face and turn the gear portion while the special multiple tools are at work on the hub. Before the operation illustrated takes place, the work has been bored, reamed and faced on the other side.

The body of the tool *H* is of cast iron and it is fastened to the turret face by the screws *J*, while the plug *K* centers it in the turret hole. The turning tools *E* and *F* are secured in the slots and a steel cover-plate *G* gives support for the set-screws which hold the tools in place. A steel shank *B* has a revolving roll *C* fastened to its lower end by the shouldered screw *D*; this roll acts as a pilot in the finished hole. The construction of this device is simple and the results obtained by its use are excellent.

Piloted Multiple Turning Tool for Triple Gear Blank

A radical departure from regular methods is shown in Fig. 12. The work *A* for which the equipment was designed is a cast-iron triple gear blank. Attention is called to the fact

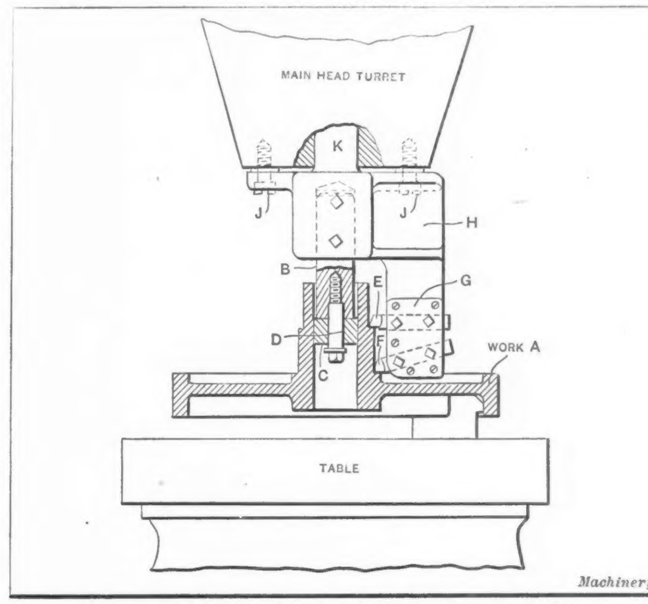

Fig. 11. Multiple Turning Tool for Vertical Turret Lathe

that in this illustration the side-head is shown in a false position in order to show the cutting action more clearly. The body *H* of the multiple turning tool is fitted to the turret and held in position by the screws *C*. A steel bushing *G* acts as an outboard support for the tool, and it is a sliding fit on the pilot *P* which is shouldered in the supporting bracket *N*. This bracket is heavily ribbed and is fastened to the bed of the machine. The adjustable washers at *M* are used to align the bracket properly. A tool-block *D* contains the two turning tools *E* and *F*, and the boring-bar *K* is held in the hub *J*. The arrangement of the side-head, in this instance, is a little out of the ordinary. A special tool-block *Q* contains the two facing tools *R* and *S*, and these work simultaneously with the turning tools, thereby making production very rapid.

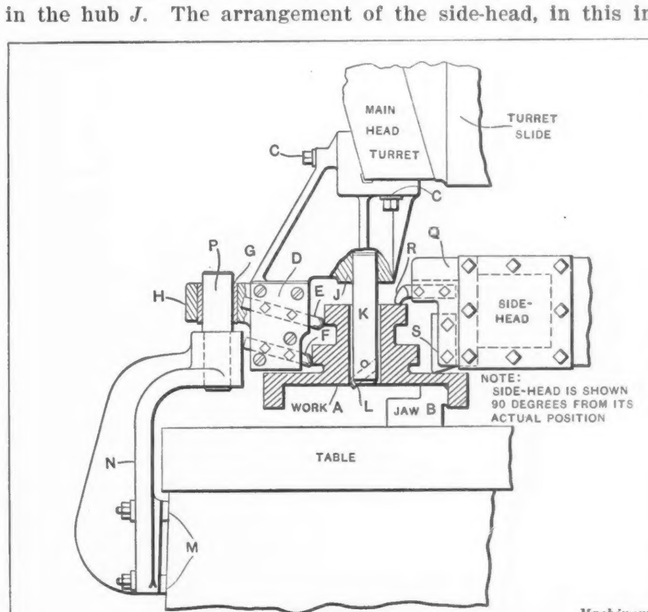

Fig. 12. Piloted Multiple Turning Tool for Triple Gear Blank

Multiple Toolpost Turret for the Side-head

The cone pulley shown at *A* in Fig. 13 was machined in one setting. The casting was held by the inside of the lower or largest step of the cone and a driver (not shown) was

placed against the interior ribbing, as the jaws were not sufficient to hold the work securely against the cutting action of the four turning tools. A special side-head turret tool-holder was designed for this piece of work, and the facing and turning tools *D*, *E*, *F*, and *G* were held in it as shown in the illustration. One set of tools was used for roughing and a duplicate set on the other side of the turret post was used for finishing. The entire group of tools pivoted on the stud *H*. While these cutters were operating on the outside of the pulley, the boring-bar *B* (held in the main head turret

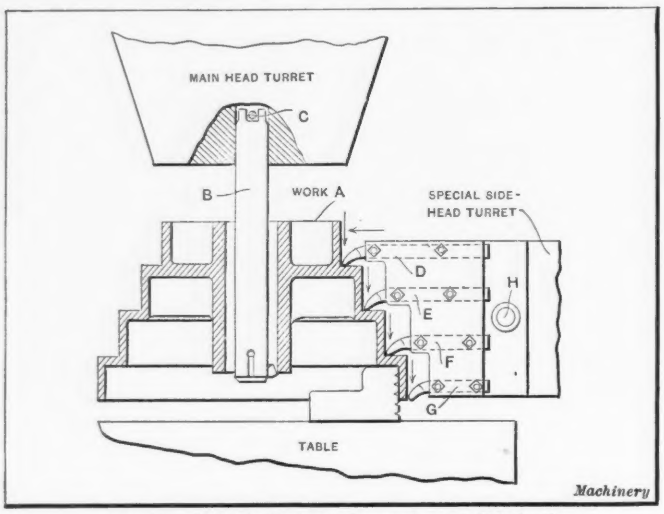

Fig. 13. Multiple Toolpost Turret for the Side-head

and driven by the pin *C*) was slowly boring out the hole. A forming plate was used to give the desired crown to the steps. The production could have been improved if a special turning tool had been used in the main head for turning the four steps of the cone, and the side-head used for facing only. These operations could have taken place at the same time, and the speeds would have been more nearly correct. The boring could have been done at a higher rate of speed. However, the

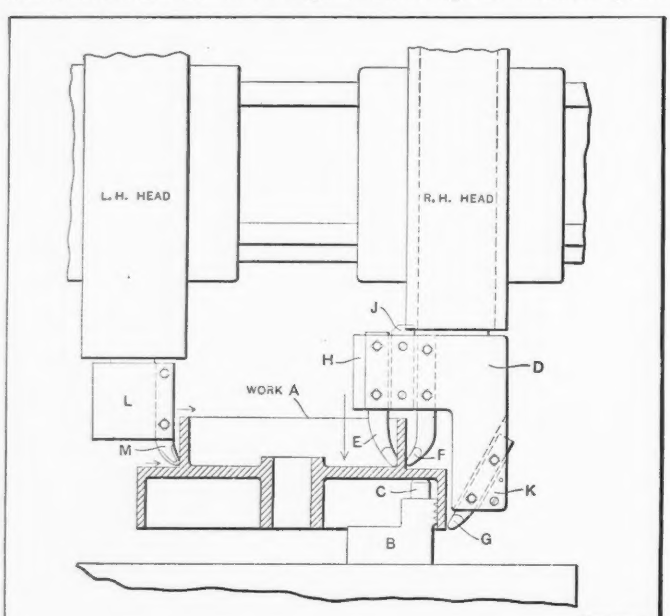

Fig. 14. Application of Multiple Turning Tool to Vertical Boring Mill

results obtained with the arrangement shown in the illustration were satisfactory.

Multiple Turning Tool for the Vertical Boring Mill

The vertical boring mill is seldom equipped with multiple turning tools, but there are cases where production can be increased considerably by their use. One example only is given of the use of an equipment of this kind. Fig. 14 shows a large pulley at *A*, and this is held by the inside of the larger step in the special jaws *B*. The buttons *C* give a three-point support to the work. A special tool-holder *D* is slotted out to receive the tools *E*, *F* and *G* which are used for the turning and boring. The plate *H* is fastened over one end of the tool-holder in order to tie it together, and the filler-block *J* gives additional strength while its upper end engages the right-hand ram and acts as a driver. Another block *K* ties the lower end of the tool-holder together. The left-hand head contains the toolpost *L* which supports the tool *M*. This tool is used for facing while the other tools are turning.

Other instances of multiple turning might be given, and illustrations shown, but these would be much on the same order as those which have been mentioned and would be of no particular value as representative types. Tools have been selected for this article which seem to best illustrate the principles of design required in the various types.

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HARROUN KEROSENE CARBURETER*

The high price of gasoline and the rapidly increasing consumption have given great interest to the efforts of inventors to produce a practicable and efficient carbureter for automobile and other internal combustion engines using kerosene for fuel. The accompanying diagrammatic illustration shows the principle of the Harroun kerosene carbureter invented by Ray Harroun and now being marketed by the Harroun Co., of Indianapolis, Ind. Part of the exhaust gases are diverted

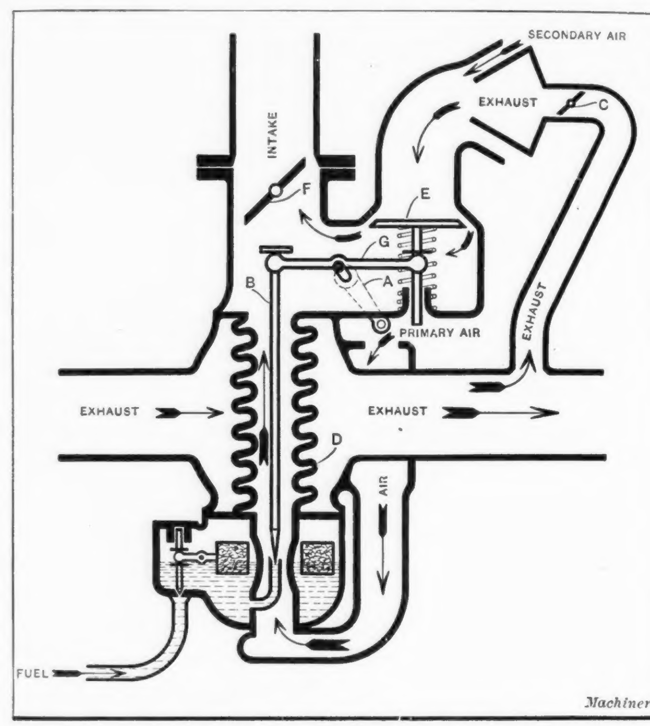

Diagram showing Principle of the Harroun Kerosene Carbureter

into a space surrounding a spirally corrugated chamber *D*. As the dense atomized fuel is drawn through this chamber by the suction of the motor, the heavier parts are thrown to the outside against the heated surface by centrifugal force and the more volatile portions of the fuel remain in the center. As the fuel is sprayed from the nozzle and comes into contact with the hot walls of the chamber it is turned into a vapor. This vapor is partially mixed with air coming in from the bottom of the chamber and is further diluted with cold air coming through the secondary air valve. The needle valve *B* in the opening of the fuel nozzle is automatically opened and closed by the action of the secondary air valve *E*. The carbureter requires but one adjustment, this being effected from the driver's seat through a suitable connection to the lever *A* on the side of the carbureter. This lever raises and lowers the fulcrum of the rocker arm *G* which is inside of the carbureter and raises and lowers the needle *B* as it is actuated by the air valve *E*.

One of the original features claimed for this carbureter is that of diverting a small portion of the exhaust gas back into the charge through the air valve opening. The discovery was made that a part of the exhaust gas mixed with the charge eliminates the disagreeable sounds which are always more

* For further information on kerosene carbureters see "Solving the Fuel Problem for the Motor Truck," October, 1913.

evident with kerosene than with gasoline fuel. Water has been used considerably to accomplish this result, but the use of water results in complications; a water supply is hard to regulate, besides being likely to freeze in cold weather. This gas mixing feature is claimed to be an advantage also with gasoline, as it eliminates "carbon knock" in any motor and also increases the efficiency of the fuel at variable speeds.

The butterfly valve *C* is provided as a means for regulating the amount of exhaust gas used. This may be worked from the dash. It provides regulation of the maximum expansion period in relation to the piston travel under varying running conditions. For example, it is a well-known fact among engineers that the fuel consumption ranges from one-half to three-quarters pound per horsepower hour when the motor is running at about 1000 feet per minute piston speed. The consumption increases rapidly, however, with either an increase or a decrease of the piston speed, sometimes being as much as one and one-half pound per horsepower hour at about 500 and 1600 feet per minute piston speed. This undesirable condition is due to the fact that the speed at which a correct mixture will burn most efficiently happens to be just right at 1000 feet per minute piston speed. A device that will retard the speed of combustion without retarding the spark timing at slow motor speeds will obviously increase the thermal efficiency. Under actual running conditions, an automobile motor is rarely pushed to its maximum or even its normal load.

The Harroun carbureter operates with either gasoline or kerosene without change of adjustment. In fact it is claimed to be a highly developed gasoline carbureter having the added feature of operating satisfactorily on cheap grocery store coal

MACHINING ARMATURE SHAFTS*

TURNING AND GRINDING OPERATIONS WHICH ARE HANDLED AT A RAPID RATE

The method of machining armature shafts has been developed to a high degree of perfection in the plant of the

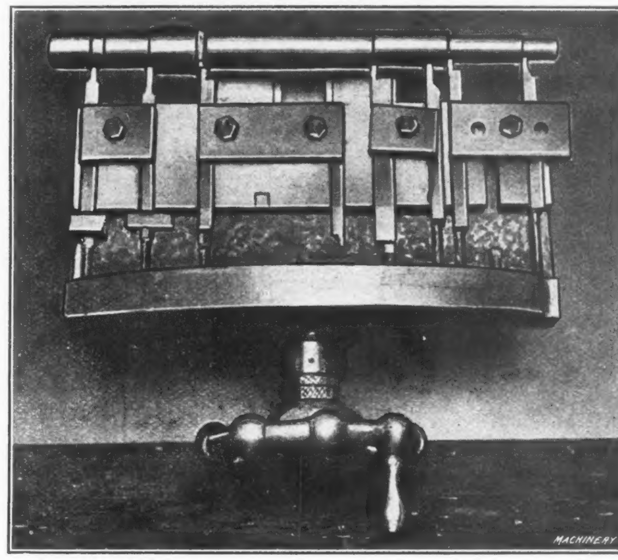

Fig. 2. Attachment used on the "Lo-swing" Lathe for necking Armature Shafts and facing the Shoulders to the Correct Length

Robbins & Myers Co., Springfield, Ohio, manufacturers of the "Standard" line of motors, generators and fans. The arma-

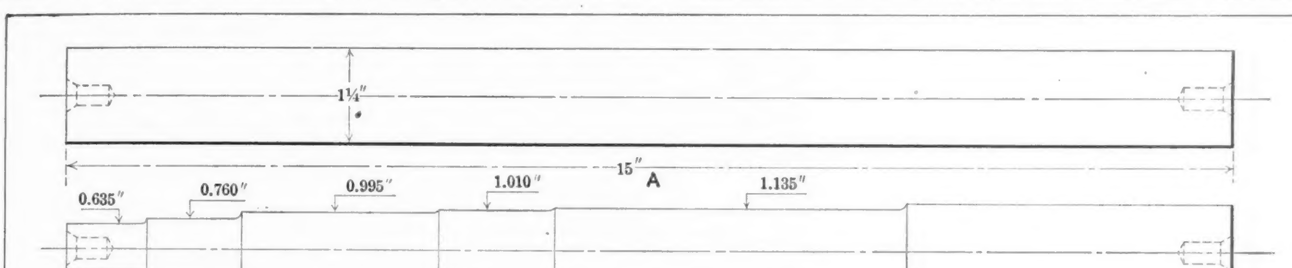

Fig. 1. Sequence of Operations on the Armature Shaft

oil. The mileage obtained is ten per cent greater when using kerosene than when using gasoline. Recent tests have shown that with kerosene fuel fed to the engine through this carbureter, a motor will haul one ton one mile for one-third cent.

ture shafts are made from 0.30 carbon machine steel, and vary in length according to the motor, fan or generator in

* For articles on shaft turning previously published in MACHINERY, see "A Lo-swing Lathe Test on Motor Armature Shafts," April, 1913; "Multiple Shoulder Shaft Turning on the Cleveland Automatic," November, 1912, engineering edition; "Turning Shafts in the Cleveland Plain Automatic," April, 1911, engineering edition.

which they are used, the one illustrated being 15 inches long. They are carried through in lots of 500, special trucks being used to accommodate this number. The operations on the shafts are given in the order in which they are handled, only those that have interesting features being illustrated and described in detail.

Preliminary and Lathe Turning Operations

The first operation on the armature shaft is shown at *A* in Fig. 1. This consists in cutting it off to the desired length and drilling and centering both ends in a No. 4 Warner & Swasey hand screw machine. Following this operation, the shaft is rough-turned in the "Lo-swing" lathe as illustrated in Fig. 3. Five different diameters are turned in one setting with multiple tools. This operation completes one-half the shaft in a setting, as shown at *B*, and when the operator has finished the entire lot the machine is reset and the other end of the shaft machined. Handling the work in this manner has proved very satisfactory and enables a production of 100 shafts in ten hours to be obtained. The bar, to start with, is 1¼ inch in diameter, rough stock, and is reduced to the dimensions shown at *B* and *C*. The operations following the rough-turning consist in squaring the shoulders to accurate lengths and under-cutting for grinding, as shown at *D*. These operations are also accomplished in the "Lo-swing" lathe, which is equipped with a special tool-holder as illustrated in Fig. 2. This tool-holder, or slide, carries seven parting or under-cutting tools that reduce or neck the shaft for grinding, and at the same time finish the different shoulders to their exact lengths. The time for necking is included in the product of 100 shafts per day.

Fig. 3. Rough-turning Armature Shafts in a "Lo-swing" Lathe

Following the necking operation, the holes in the ends of the shaft are tapped in a Cincinnati drill press, and the keyway in one end and the slot in the other end are cut in a Whitney hand miller. One end of the shaft, as shown at *E* in Fig. 1, is threaded and this operation is accomplished in the hand screw machine, using a self-opening die.

Finishing Operations on Armature Shafts

The final operation on the armature shaft is grinding the different shoulders to the exact diameters, which is accomplished in the 6 by 32 Norton plain grinder shown in Fig. 4. The operator, instead of finishing one shaft at a time, puts through the entire lot by grinding only one diameter at a setting and by using a 2¼-inch wheel and feeding it directly in to the work instead of traversing the table. This procedure is followed except in cases where the bearing on the shaft is longer than the width of the wheel used, which would necessitate traversing the table. By referring to Fig. 1 it will be be seen that all but one bearing can be ground without traversing the table. It will also be noticed that the bearing on the extreme right end of the shaft is tapered an amount equal to 0.001 inch in its length. This is accomplished by truing the wheel with a diamond, the table being set over the required amount. In operation, the wheel is fed directly in to the work—not traversed.

On an average of 0.010 inch is left on the diameter of the shaft for grinding, except on the 1¼-inch diameter where it is necessary to remove about 1/32 inch. As shown at *E* in Fig. 1, there are eight bearings or shoulders on the shaft that can be ground in the manner previously described; that is, by feeding the wheel directly in to the work—not traversing the work longitudinally. As each shoulder on the lot of shafts is ground at a setting, it is not necessary for the operator to change the position of the table in relation to the wheel, any slight variation in the depth of the centers being taken care of by the nicks in the shafts. As soon as the wheel becomes slightly glazed or clogged, it is trued up with a diamond and straightened so that the bearing produced is accurate as regards diameter and straight from one end to the other. The automatic cross-feed and knock-out on the machine are used, and when one shaft is being ground the operator is placing a dog on the other, so that the only time lost is that required to remove and replace the shafts on the centers of the grinding machine. When all the bearings less than 2¼ inches in length have been ground, the machine is reset to grind the remaining long bearing, thus completing the grinding operations. The limits on the grinding operations are in many cases only 0.0005 inch. The grinding of only one bearing at a time has been found to be highly economical and efficient, as a production of 105 completed shafts in ten hours proves.—D. T. H.

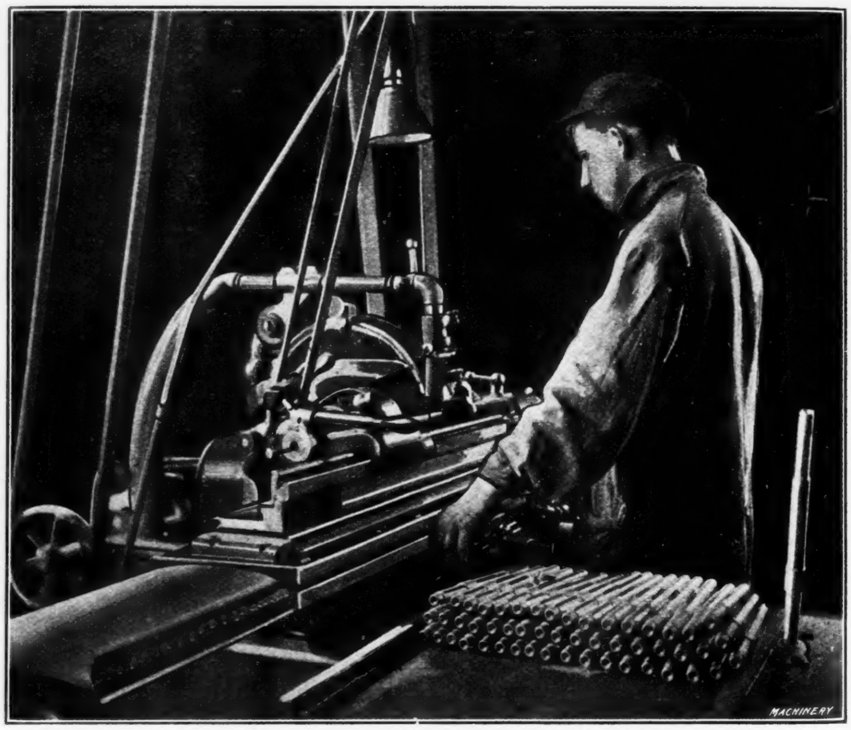

Fig. 4. Grinding Armature Shafts on a Norton Plain Grinding Machine

* * *

It is very unsafe to say that a thing cannot be done or that it must prove a failure. It is by far the safer course, at least in things mechanical, to admit that while it does not seem probable—you never can tell.

FOUR-SPINDLE REAMING ATTACHMENT FOR MOTOR CAR CYLINDERS

BY C. BOELLA*

In order to increase the production of cylinders for small motor cars, cast *en bloc*, the attachment shown in Fig. 1 was designed for application to a regular drilling machine to avoid buying an expensive machine. These cylinders were required in large quantities and high-grade machine work was necessary. A large Niles vertical drilling machine which was already used to ream cylinders, was fitted with the special attachment.

The attachment has a heavy cast-iron base firmly bolted to the machine table. This base has two perpendicular side walls provided with finished surfaces at the ends which are exactly square with the base. The base of the cylinder which, previous to the reaming operation is planed to the exact size, is placed in the fixture between the vertical sides. The latter are fitted at the back with suitable stops, against which the cylinder base bears. The cylinder is held to the fixture by four pivoted clamps which are inserted through suitable square

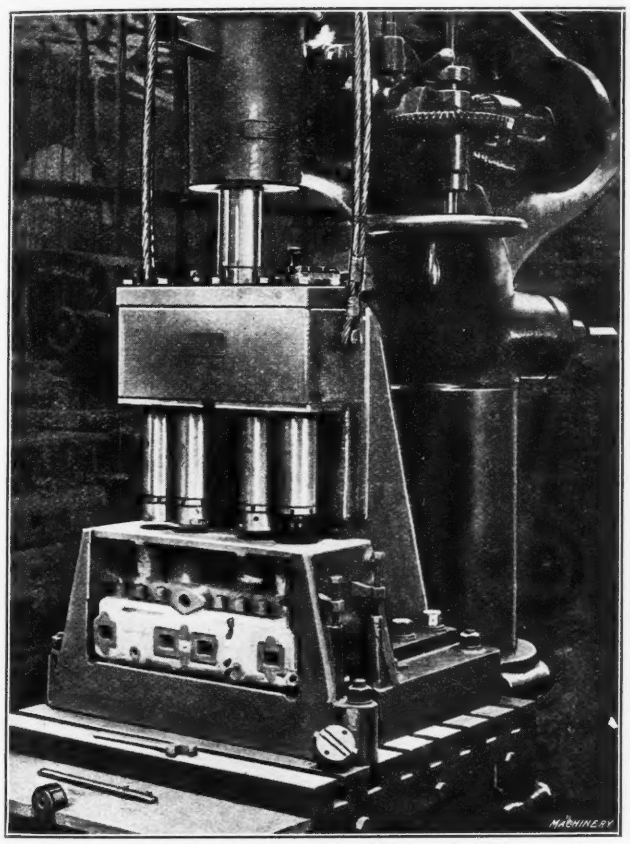

Fig. 1. Four-spindle Reaming Attachment and Fixture with Cylinder in Place

holes in the uprights. These clamps are tightened by screws in the ends which engage projecting lugs, as shown. A large channel at the base of the fixture just under the casting, provides room for chips and makes it easy to remove them.

The four tool spindles are mounted in a slide which is carried by a strong, heavily ribbed column that is bolted to the base of the fixture. Fig. 2 shows a plan view of the spindles and slide. In order to insure exact alignment of the slide during its traverse, it has been fitted with a central dovetailed guide *A*, which being narrow relative to its length, insures accurate movement of the slide. The taper gib *B* is adjustable endwise for taking up wear, the holes for the bolts being made oval to provide play for the taper gib adjustment. The gear *D* fitted to the spindle drives gears *E* and *F* which, in turn, drive gears *H* and *G*, these four gears being fitted to the tool spindles.

Fig. 3 is a vertical section through the tool-slide. A shaft D_1 is screwed to the lower end of the spindle *J* of the machine, and gear *D* drives the tool spindles, as previously explained. A ball bearing *K* is provided to take the vertical thrust of the tools, and plugs *L* screwed in the slide cover are used for vertical adjustment of the spindles. Each tool spindle is surrounded by a heavy steel tube *M*. This tube is fitted with a bushing *N* at its upper end and a smaller bushing *O* at its lower end. The latter is tapered externally and is adjusted by screwed ring *P*. The lower bearing is very close to the tool so that the spindle is rigidly supported.

The tools are fixed to the spindles in a peculiar way, each spindle being tapered to an angle of 20 degrees and fitted with a bayonet clutch. This clutch is engaged by a pivot that is

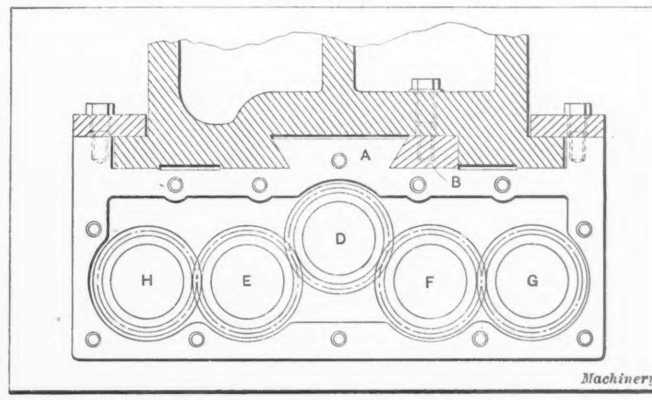

Fig. 2. Plan View showing Arrangement of Spindles of Reaming Attachment

integral with the tool-holder, thus holding the latter onto the taper part of the spindle. With this arrangement, the tools are centered accurately and are held rigidly even after long use; it also allows cutters to be easily removed. Fig. 4 shows the tool which is used both for roughing and finishing. It has a cylindrical body bored tapering to fit the conical end of the spindle. The lower face has a large dovetailed groove in which the two tools are held. These tools are of simple form and are fixed in position by tapering gibs. These tools permit heavy cuts to be taken with heavy feeds and high speeds without chattering.

Experience has proved that multiple cutters are not suitable for this kind of work because of the difficulty of setting them

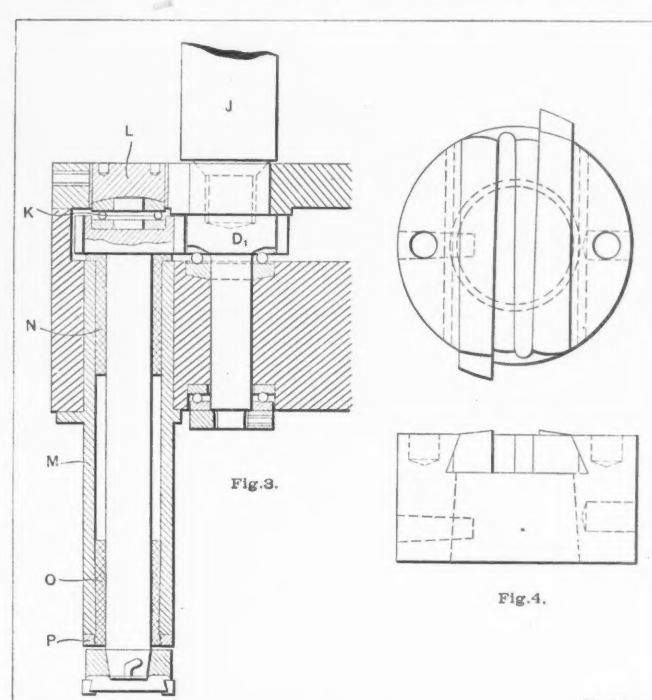

Fig. 3. Vertical Section of Spindle. Fig. 4. Cutter-holder and Cutters

up and fixing them rigidly enough to resist the strain of such hard usage. With the tools described, remarkable results have been obtained. A cylinder of 3- by 9-inch size is rough-bored in twenty minutes and finished in twelve minutes. Better results could be obtained were it not for the excessive heat generated, which is liable to impair the accuracy of the work. The depth of the cut during the roughing operation is about 1/8 inch and the finishing cut about 1/64 inch. The holes are

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quite smooth, straight and parallel and are located exactly with relation to the base.

As the slide with its spindles is heavy, it is necessary to counterbalance it. It was not convenient to increase the counterbalance weight of the machine spindle, so the slide was counterbalanced separately. Two wire ropes were attached to the sides of the slide, as shown, and these pass over grooved pulleys attached to the ceiling and connecting with suitable counterbalancing weights. As changing the cylinders is easier than changing the tools, for repetition work, it is better to rough a quantity of cylinders and finish them afterward.

* * *

BROACHING VS. REAMING

BY FRANK J. LAPOINTE*

The broaching of round holes has been adopted within the last few years by many manufacturers on certain classes of work in preference to reaming. This change is due to two reasons: The cost of the operation is less and the finish on the particular work referred to later is superior to that of reaming. It might be of interest to the readers of MACHINERY to know some of the conditions connected with broaching round holes, and the comparative time between broaching and reaming them.

It is an acknowledged fact that the boring and reaming of seamless steel tubing, especially when the walls are light, is not a very satisfactory operation; in fact, the pieces are usually distorted, due to the method of holding them. One of the principal objections to reaming, and one reason why it is so hard to obtain a well reamed hole in steel tubing, is that the reamer tears or "bites in" at some point on the surface. This is due to the fact that the fibers of the steel are drawn lengthwise or at right angles to the cutting edges of the reamer, which is one of the reasons why it is so hard to obtain a good clean finish in steel tubing by reaming.

On the other hand, when broaching the hole in a tube, a very nice finish can be obtained because the fibers lie or are drawn in the same direction as the broach is operated. The ordinary seamless steel tubing is about 0.008 to 0.030 inch under standard size, which is just a nice amount to broach out. For broaching this material, with diameters up to 2 inches, we broach on the high speed of our broaching machine, or with the cutting tool traveling at about six feet per minute. There is no clamping of the work for this operation and the shell is not distorted anywhere nearly as much as it would be by boring or reaming. Six or seven pieces can be broached while one is being reamed.

The writer recently had the pleasure of visiting one of the largest automobile gear manufacturers in the country and was pleased with the results they are obtaining in broaching round holes. The operation is on sliding gears and differential gears. The method of machining these pieces has been changed from the ordinary way to the following: The work is placed on a drill press, in a suitable fixture, and the holes, which vary from 1 1/16 to 1 1/2 inch in diameter, are drilled in one operation with a drill 1/32 inch smaller than the finished size of the hole. On the spindle of the drill press a facing head is arranged so that after the hole is drilled, the spindle is fed down and the gear faced off by this facing head; this forms a flat surface which is square with the hole and is used for locating the work while broaching. The old method was to drill these gears, then follow with a light boring chip, and then a reamer. I was informed that the reduction in price on this work was 1½ cent per hole, which is quite an item when we consider that the original cost of machining the holes was very low, and to reduce it 1½ cent per gear was well worth changing the operation.

The results obtained by broaching are that a well finished hole is obtained in addition to greater production; moreover, the life of a broach is eight to twelve times that of a reamer. Another operation of broaching round holes that may be of interest is carried on in our own plant. All bearings of bronze under 2½ inches diameter, are broached instead of being reamed. This is done for several reasons:

First, broaching is our business; second, it is the most profitable way for us to handle the work; third, there is less waste of material; fourth, the production is eight times as great; and fifth, we always have plenty of broaching machines on the floor to be tested out. Take, for instance, the broaching of a 2-inch round hole in bronze castings 4½ inches long. We allow 1/8 inch of stock to be removed or 1/16 inch on each side, the hole being cored ⅛ inch smaller than the finished diameter. When we were boring and reaming these holes to size, ¼ inch was allowed and the average time was ten minutes per piece. They are now broached at the rate of one in 1¼ minute and the pieces are not clamped and do not lose their shape. The finish of the broached holes is better than was obtained by reaming. The trouble when reaming hard bronze is to overcome the chattering and waving of the reamer in the hole; this has been done by broaching.

The results when broaching round holes depend on the tool itself. The broaches are ground all over after hardening and are backed off at the proper angle to give them a nice cutting edge. The teeth are nicked to break the chips on the heavy cutting part of the broach, but the last six or eight teeth that do the sizing are not nicked. Following the last six or eight sizing teeth is a short pilot which supports and guides the broach. One very important thing in broaching round holes is the proper spacing of the broach teeth. At no time must there be less than three teeth in the work, in order to properly support the broach; if the teeth were so coarse that only one tooth was cutting while another was entering, it would give the broach a slight movement, causing waves in the work. The broach must always be made up with differential spacing of the teeth. If the teeth are all evenly spaced, as a rule very unsatisfactory results will be obtained.

When making broaches a number of things must be taken into consideration, *viz.*, material to be cut, length of work, amount of stock to be removed on the outside, and the shape of the work, so that the proper support can be provided. The length of the broach depends entirely on the metal to be removed. Of course in cases where the broaching operation is for sizing, a short broach is used, usually having about 10 inches of cutting edge. If the broach is to remove ⅛ inch of stock, the length may vary from 28 to 40 inches, depending on the length of the work.

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* * *

In a discussion of the value of graphite as a lubricant at the December meeting of the metropolitan section of the Society of Automobile Engineers, Marcus A. Smith, lubrication engineer of the International Acheson Graphite Co., described some of the peculiarities of deflocculated graphite. The subdivision of graphite particles has been carried to such a point that they permeate the pores of the metal and in that way build up a surface layer in which the carbon particles are intimately associated with the metal. Such a surface is termed a "graphoid" surface. By adding one-quarter per cent of deflocculated graphite to lubricating oil it is possible to carry to all surfaces a material that is finer than the most minute pores of the metal and which will gradually saturate the metal with a lubricant that heat does not destroy. The minute size of these particles is indicated by the fact that 339,000 particles of deflocculated graphite, placed side by side, extend one inch. The claim is made that the benefits derived from deflocculated graphite diffused in oil are accumulative, for by continued use all the bearings, cylinder walls and piston rings are protected by a lubricant which impregnates the metal, and if at any time the supply of lubricant is shut off, the coefficient of friction remains practically unchanged for many hours of use.

* * *

The Bureau of Foreign and Domestic Commerce suggests in a recent consular report that all communications to the United States consular officers be addressed "The American Consul, at ——," the name of the officer not being given. Any communications so addressed will be opened and attended to by the person who happens to be in charge of the consular office at the time the communication is received. If addressed to the consul by name, it is likely to be forwarded to him unopened, should he be absent, and unnecessary delay would thus result.

REBUILDING A PIPE THREADER

BY A. P. CONNOR*

We were recently called upon to rebuild an old style manually operated Saunders pipe threader in order to take advantage of the increased facility with which a power driven machine could be operated. The provision of suitable gearing would evidently make it possible to change or reverse the speed at which the machine was driven; at the same time it was desired to retain the features of portability, adjustability and a degree of stability which would adapt it for rough usage. The machine had been in operation for a number of years but was still in good condition, so that the problem of rebuilding was limited to the change from hand to motor drive.

In order to have the machine as light as possible, it was decided to do away with the shelves that were located under the bed of the original machine. The lower shelf was replaced by a platform mounted on connecting stays secured to the legs. A ½ horsepower motor was mounted on this platform and means for adjusting the alignment of the motor spindle was provided by four bolts. It will be seen that two nuts are provided on each of these bolts, one nut being above the base of the motor and the other below it. By regulating these nuts, the alignment of the motor spindle can be adjusted to insure having the belt run properly. The arrangement is clearly shown in the illustrations, where it will also be noticed that the motor is located under the machine where it is out of the way.

The headstock housing was reversed in order to locate the driving mechanism at the opposite side of the machine from the position where the operator stands, and the whole machine was set over on the base a distance of 2½ inches toward the operating side in order to balance properly and avoid too much

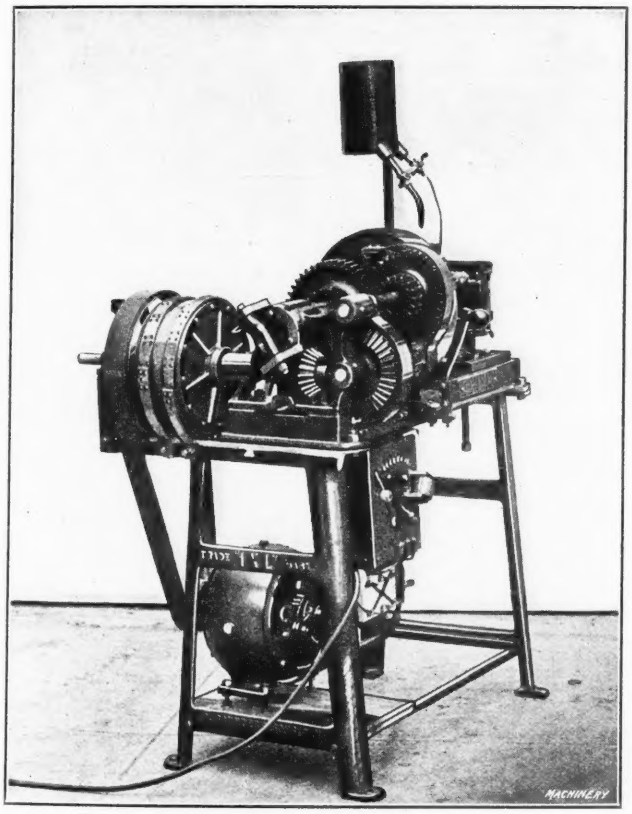

Fig. 1. Operating Side of the Rebuilt Pipe Threader

overhang on the driving side. The familiar form of planetary transmission used on automobiles was adopted, the gear reduction obtained in this way being one to three on the forward and slow reverse speeds. A high-speed reverse was also provided. All speed changes are obtained by a single operating lever. This lever is shifted to the right or toward the die carriage for threading; in order to reverse the direction of rotation of the stock for backing out the work, the operating lever is thrown into the left-hand position; and to stop the machine, the lever is moved to the middle. In order to obtain the high reverse speed, the operating lever is shifted a slight distance off center to the left. From the preceding description it will be noted that the motor connections are not touched in operating the machine and that it is unnecessary to alter the resistance of the electric circuit in order to obtain any of the results referred to.

A friction clutch mechanism is used in connection with the operating lever, which gives a very smooth action and avoids the possibility of breaking gears or otherwise damaging the machine or motor through sudden shocks. The full horsepower of the motor is available all the time that the machine

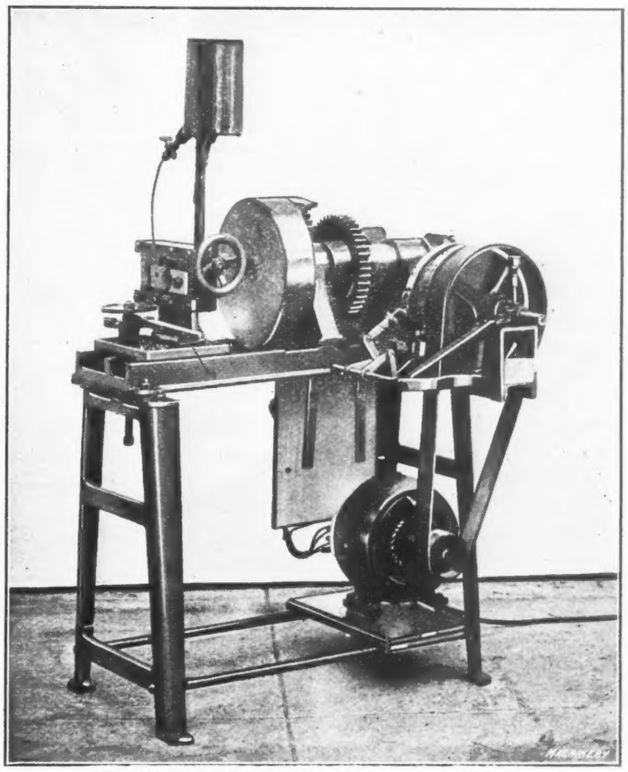

Fig. 2. Rear View of the Rebuilt Pipe Threader

is running. The belt speed must necessarily be high, owing to the type of motor used, and this would ordinarily entail the use of a large driving pulley on the machine. This objectionable feature was done away with by the use of the planetary gear reduction in connection with the regular gearing on the machine. It will be seen from Fig. 1 that the rheostat for the motor is mounted under the bed of the machine so that it is convenient for the operator and at the same time assists in counterbalancing the weight of the motor. The main circuit switch is placed under the rheostat. As the motor only develops ½ horsepower, it can be connected to an ordinary lamp socket with the usual form of attachment plug. The weight of the machine was held within a limit which enables it to be moved about from one job to another, and it is unnecessary to bolt it down to the floor. Solid dies are used, as they have been found most desirable for the class of work for which this machine is intended. The oiling arrangement is essentially the same as that used on the original machine.

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* * *

MAKING COPPER WIRE BY ELECTRO-DEPOSITION

A process has been devised for the manufacture of copper wire by electro-deposition. According to the *Brass World*, previous attempts to manufacture wire by this process have been unsuccessful. A fine copper wire is used as a core and the additional copper is deposited on it while moving through a tank containing the solution. The fine copper wire is made endless and passes through a regular plating solution containing sulphate of copper and a little sulphuric acid. After leaving the tank, the wire passes through a small rinsing tank to remove the solution, and then, after making a number of turns around a reel, it returns to the plating tank. The plating is thus continued until a wire of the required diameter is obtained.

PRESS TOOLS FOR CLIPPING AND PIERCING BRASS SHELLS

BY JOHN F. FORBES

The illustrations show several interesting forms of press tools for performing clipping and piercing operations on brass shells. Fig. 1 shows the shell *A* which is to be clipped along the dotted line, and at *B* and *C* two views of the completed shell are shown. The die used for this clipping operation is illustrated in Fig. 2. The die *A*, over which the shell slips is a hardened steel collar which is made to fit the shell accurately. This die is driven onto the stud *B* and held in place by means of the dowel pin *C*. The stud *B* is a press fit in the die-bed and is prevented from turning by means of the key *D* which serves the additional purpose of locating the stud in the desired position.

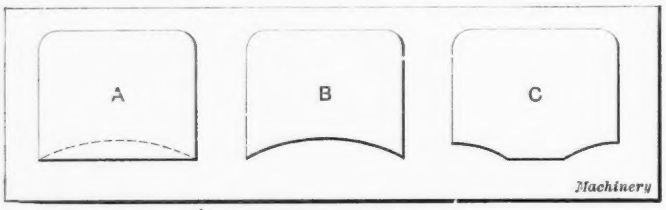

Fig. 1. Shell A to be clipped along Dotted Line and Two Views of Clipped Shell

The clipping punches *E* are mounted on two dovetailed slides in the die-bed. This construction will be readily understood by referring to the cross-sectional view of the die-bed along the line *X-X*. Allowance is made for any adjustment of the punches that may be necessary on account of grinding by the provision of elongated holes for the screws which secure the punches to the slides. In case any adjustment is made, a shim of sheet steel of the required thickness is placed between the back of the punch and the slide; this gives the punch a bearing on the slide and relieves the screws from the pressure of the cut. The punches are made to conform accurately to the cutting edge of the clipping die, the contour of this cutting edge being clearly shown by the dotted lines in the two views of the die which are shown in Fig. 2. The faces of the clipping punches conform to the circumference of the shell and the points *E* cut a little in advance of the remainder of the punch in order to insure having the shell clipped without leaving a fin or burr of any kind.

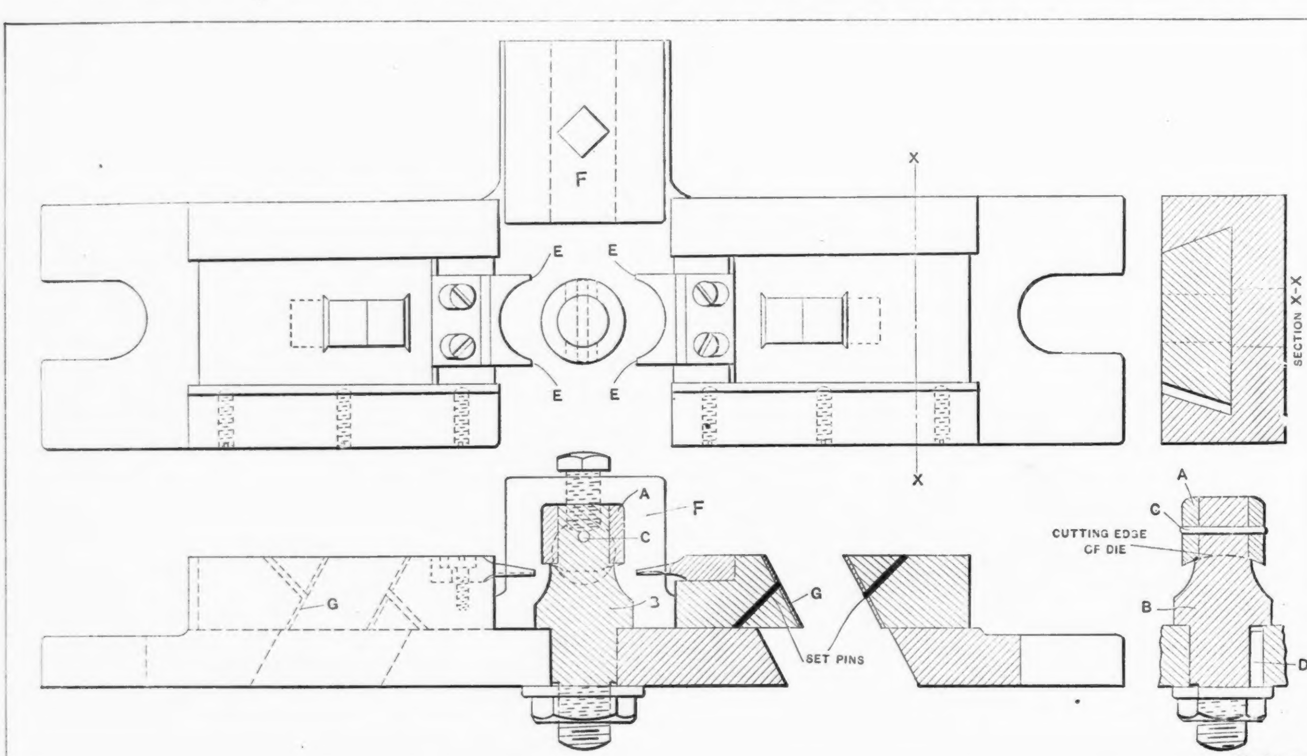

Fig. 2. Die-bed equipped with Tools for clipping Shell shown in Fig. 1

Operation of the Tools and Die-bed

In order to clip a shell with this set of tools, the work is placed over the die and the press is then tripped. The punch shown in Fig. 3 is held in the ram by means of the shank *A*. When the ram descends, the inner surfaces *B* of the arms which are inclined at 30 degrees, come in contact with the steel pads *G*, Fig. 2, in the slides that carry the clipping punches and move them in toward the die. This brings the clipping punches into action and causes the shell to be clipped. When the ram starts its return stroke, the outer surfaces *C* of the arms on the punch cause the slides which carry the clipping punches to be returned to their original positions. It will be obvious that this method of actuating the slides is positive in action and does away with the use of springs for returning the slides. It will be seen that the punch-holder *D*, shown in Fig. 3, has a small piercing punch *E* mounted in it.

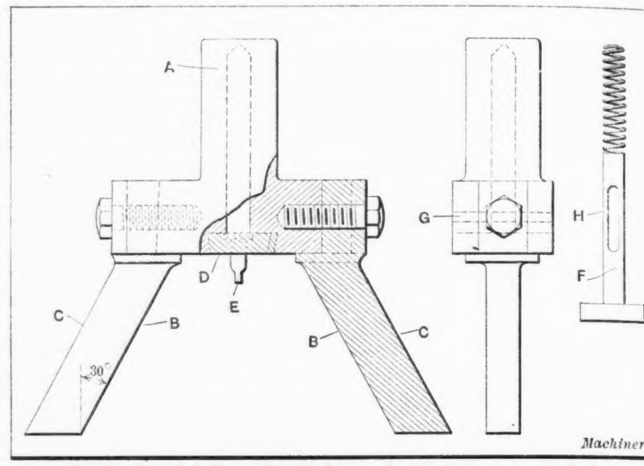

Fig. 3. Punch-holder with 30-degree Angle Arms to control the Movement of the Slides

This piercing punch is used in an operation that will be described in a subsequent paragraph. When the tool is used for the clipping operation, the piercing punch *E* and the punch-holder *D* are removed from the punch and the "hold-down" *F* is mounted in their place. This hold-down is held in place by means of a pin *G* which fits in the slot *H*, the length of the slot being sufficient to allow the hold-down the necessary amount of movement. This hold-down moves a little ahead of the clipping punches and thus comes into contact with the top of the shell and holds it securely in place

so that it cannot be raised off the die when the clipping punches begin to cut.

Construction of the Die-bed

The shells that are clipped or pierced on this die-bed are ordered in lots of not over 25,000. This fact made it desirable to make a die-bed that could be used for both clipping and piercing operations, and this advantage is obtained by the design shown in Fig. 2. This would not be of much advantage, however, if the work had been ordered in large quantities which would require the same set of tools to work day after day in order to get it out. In some cases, it was found desirable to provide special slides for a given set of punches

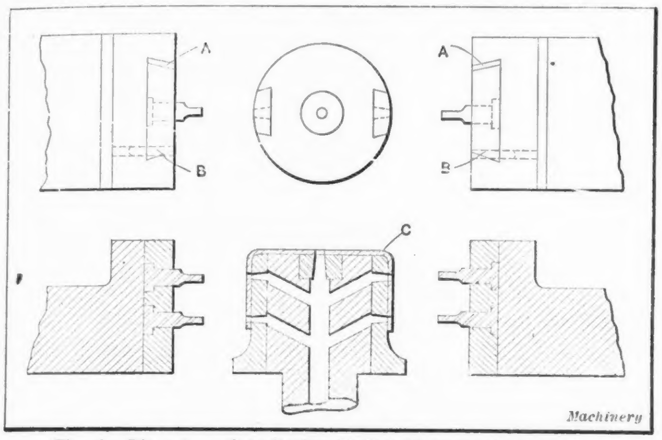

Fig. 4. Die set up for piercing Shell held in Vertical Position

and the clipping punches shown in place on the die-bed in Fig. 2 are an example of this kind. When these punches are removed, the slides are taken off with them and the regular slides can then be put in place on the die-bed in order to allow other tools to be set up. It will be seen that gibs are provided to enable any wear which may develop in the slides to be taken up.

The construction of the die-bed is such that shells can be held in either a horizontal or vertical position. This will be better understood by referring to Figs. 4 and 5 which show shells mounted in the vertical and horizontal positions. The shell *C* which is shown in position on the die in Fig. 4, has five holes pierced in it. Two of these holes are pierced in either side of the shell by means of piercing punches carried in the slides of the die-bed, while the fifth hole is pierced in

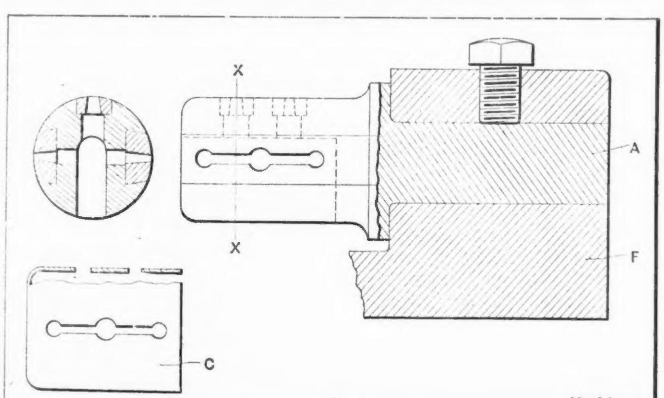

Fig. 5. Die set up for piercing Shell held in Horizontal Position

the top of the shell by means of the piercing punch *E*, which is shown in position in the punch-holder in Fig. 3. The piercing punches for working on the sides of the shell are mounted in regular slides of the die-bed shown in Fig. 2. Referring to the top view in Fig. 4, it will be seen that these punches are mounted in dovetail holders which are held in the desired position by means of keys *A*. The pins *B* locate the punches in their proper positions and are particularly convenient in obtaining the desired alignment when setting up the tools after they have been removed for sharpening.

Fig. 5 not only shows the construction of the piercing die for piercing the shell *C*, shown at the left-hand side of the illustration, but also illustrates the way in which the work is held in a horizontal position in the same die-bed that is used for holding work in a vertical position. Referring again to the illustration Fig. 2, it will be seen that the part *F* at the back of the die-bed has a hole in it to receive the shank *A* of the piercing die-holder which is held in place by means of a set-screw. The shell *C* which is pierced on this die, could be pierced in a vertical position but this would necessitate a three-slide die-bed. Where the present method is used, the slot at either side of the shell is pierced by punches carried in the slides of the die-bed and the two small holes at the top of the shell are pierced by two punches carried in the punch-holder mounted in the ram of the press. In the case of the die used for piercing this shell, and all of the other dies referred to, it will be seen that a space is provided to allow the scrap and dirt to drop out at the bottom of the die.

* * *

HE DID NOT BELIEVE IN OIL

BY A. P. PRESS

Our friend Bill blew in the other day. He was the same old Bill that came in a year ago. The cigar with the gold band that he handed out was a little fatter, and it smelt a little more as though it came from Havana; his waist line had increased two inches—otherwise he was the same good fellow that we had always known.

"Well Bill, what are you doing?" was our question after he had settled down in the best chair in the office, pulled up his pants, and got his cigar to going.

"Well boss, I'll tell you. I am 'trouble man' for the Easy Car Co., and I am down this way to straighten out a little trouble. The trouble was so darned mean that I couldn't rest until I told someone about it, and so I came in to see you.

"About three months ago, we sold a big six-cylinder car to a dentist down here. The car was tested out. I took a ride in it myself, and it was shipped down to him in the usual way. The 'toothache man' took the car and paid for it, and wrote us a nice letter about how well pleased he was; then a week later, the trouble started in, and from that day until I came down a week ago, there has been nothing but kicks, complaints and cuss words.

"The 'Super' called me in his office last week, and said, 'Bill, go down there and fix that thing somehow. We don't know what's the matter, and we don't think the dentist does either, so find out.'

"Well, I came down, went over to the garage, and there my friend was waiting for me. I went all over the car, and I got down on my back and went under it; took off the crank-case, then took off one cylinder, and Mr. Press, what do you think? That darned fool—excuse my French—had been running that car for three months without a drop of oil in use anywhere. Transmission, engine, rear axle, in fact, the whole car, had never made the acquaintance of an oil-can. When I crawled out from underneath the car, I was mad clean through. There is no society for the prevention of cruelty to automobiles—if there was, I would like to be both secretary and president.

"When the dentist commenced to lamb it into me, I could not hold in a minute. 'Mr. Dentist,' says I, I said the words just as slowly and softly as I could, so as not to make a break, 'if I could buy you for what you really know about a car and then sell you for what you think you know, it would be the greatest gold brick proposition I know of. A man that would take a car like that, and run it three months without a drop of oil hadn't ought to be allowed to have a car. If you can't afford the oil, you should not have bought the car; and if you can afford the oil and don't know enough to put it in, you should not be allowed to drive a car.'

"What did he say? He turned red and yellow, and at last turned white and said that he supposed the garage man, or the errand boy, or the typewriter had always filled it up. I straightened the matter out. I told him before I started that it would cost $1 for every hour I spent on the car. He paid the bill like a man and gave me a dozen of these cigars, and I think you will agree that they are good ones too. So long." Then Bill went out.

FIXTURE FOR PLANING CLUTCHES IN THE SHAPER

BY C. BOELLA*

We had to manufacture a large number of four-tooth clutches for motor car starting handles. Formerly the teeth of these clutches were machined roughly with a milling cutter and finished by hand, but this method, besides being too expensive, was not giving uniform results. To avoid this defect and increase the production, a special fixture was designed.

This fixture is shown in Fig. 1 applied to a Hendey shaper. It consists of a cast-iron bracket bolted to the table of the

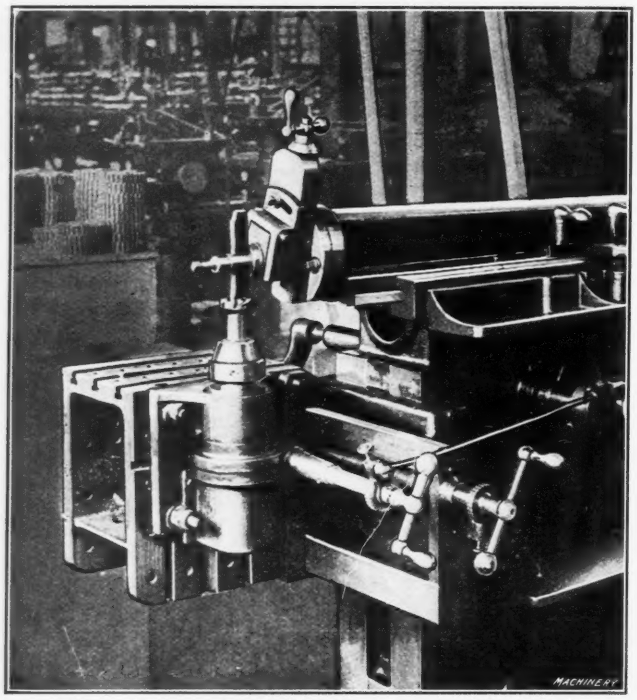

Fig. 1. Shaper equipped with Fixture for generating Helical Clutch Teeth

shaper, which has at its lower end, a hardened four-tooth half-clutch B_1 (Fig. 2) similar in form to the clutch to be made. The other half B of the clutch is also made of hardened steel and is fixed to the end of a spindle which both revolves and moves vertically. On the upper end of the spindle the work is held by means of a split collet. The spindle receives its rotary motion by a revolving sleeve driven by worm and worm-wheel A. The worm is rotated either by the handle shown at the end of the worm shaft in Fig. 1, or automatically by means of a ratchet and pawl which is similar to the device used for feeding the table. This automatic feed derives its motion from the regular feeding mechanism of the machine. A spiral spring keeps the rotating half of clutch B in contact with the lower clutch B_1 which is attached to the bracket.

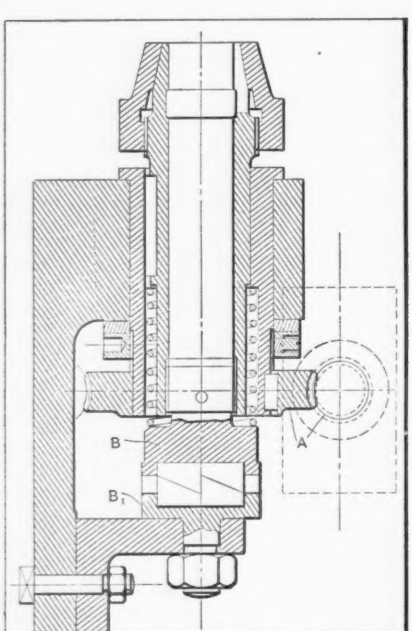

Fig. 2. Vertical Section of Fixture shown in Fig. 1

The fixture operates as follows: When the worm-wheel is revolved by means of the handle, the sleeve rotates driving with it the spindle carrying the work. This spindle, on account of the hardened four-tooth clutch fixed to its lower end, receives besides the rotary motion, an upward movement which lasts for a quarter of a turn; it then drops to its lower position and, as the rotary movement continues, it again rises, and so on for each succeeding quarter turn.

Prior to forming the clutch teeth, the tool-slide is inclined to a suitable angle and four slots are cut at points corresponding to the faces of the teeth and to a depth represented by the lowest position of the arbor carrying the clutch. The slotting tool is then replaced by a forming tool set as illustrated. As previously mentioned, the arbor turns and rises simultaneously for a quarter turn so that the planing tool generates a helical or spiral tooth. When the arbor drops to its initial position, the tool starts forming the second tooth, and so on until the whole clutch is finished. Good results as regards both output and accuracy are obtained with this simple fixture. The clutches are well machined and can be used without further finishing.

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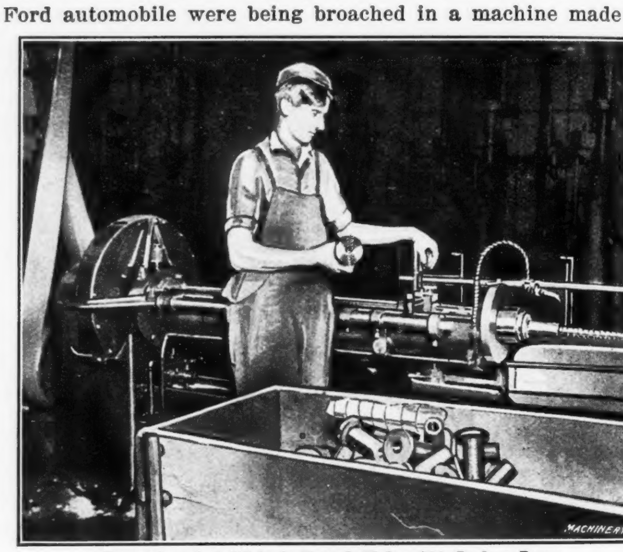
* * *

BROACHING VS. REAMING

Broaching, as generally understood, has been considered to be applicable only to the economical production of holes that are not round, such as square, hexagon, etc., but it has been found that round holes can be effectively broached for two reasons. First, the work can be much more quickly accomplished by broaching than by reaming; and second, the hole produced is smoother, free from objectionable "rings," and accurate as to size. An excellent example of the broaching of round holes was secured in Dodge Bros. plant in Detroit, where vanadium steel forgings used in the manufacture of the Ford automobile were being broached in a machine made by



Broaching 1 3/16-inch Round Holes 5½ Inches Long in Vanadium Steel Drop-forgings

the Lapointe Machine Tool Co., Hudson, Mass. The forging, which is 5½ inches long, is first rough-drilled in a high powered vertical drilling machine, from 0.005 to 0.010 inch being left on the diameter of the hole to be removed by the broach. The forgings are brought directly from the drilling machine to the broaching machine and the hole, which is 1 3/16 inch in diameter, is completed in one pass of the broach, a production of 750 being obtained in ten hours.

The fixture used is of very simple construction, consisting simply of a cast-iron ring fastened to the faceplate of the machine, against which the forging is held by the broach as it is drawn through. The spacing or pitch of the teeth in the broach is about equal to the diameter, and a small straight portion about 1¼ inch in length is provided on the end of the broach, which passes through the hole and gives it a burnished appearance. The hole produced by a broach is superior as a bearing surface to that produced by a reamer. This is because when the reamer is working in alloy steel, especially that containing a percentage of nickel, it usually tears rings around the hole, producing a rough surface. The broach, on the other hand, if it produces scratches or tears at all, makes these in a line parallel with the axis of the work, which is less detrimental to a bearing surface than annular grooves.

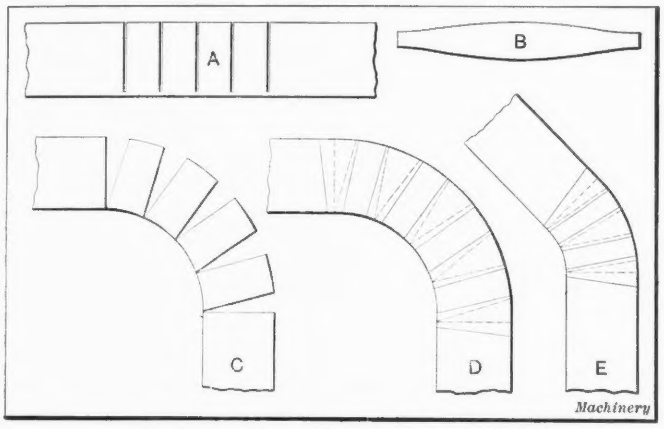
D. T. H.

MAKING BENDS FROM STRAIGHT SHEET METAL PIPES

BY FOREMAN PLATER

In large engineering works and factories, light sheet metal piping is used for various purposes such as ducts from ventilating fans, dust exhausting pipes from grinding and polishing machines and a number of similar uses. Wherever piping is used, right-, obtuse- or acute-angle bends play an important part, and it may be mentioned in this connection that the ordinary stove pipe bend or elbow cannot be used in a system of piping used in connection with a fan. The resistance produced by the sudden change in direction of the air moving at high velocity always has a serious impeding effect upon its movement. In order to reduce resistance as far as possible, right-angle bends should have the radius of curvature at the inside of the bend equal to at least the diameter of the pipe. Right- and obtuse-angle bends in sheet metal piping are generally produced by machinery, and most large firms carry a stock of the different diameters which they use. The machine-made bends are naturally cheaper than hand-made ones. However, in handling small jobs of sheet metal pipe work it is not always advantageous or advisable to use the ready-made bends.

It has often been the writer's experience to be called upon to make ventilating or dust collecting ducts that require bends



Method of making Bends from Sheet Metal Pipes

other than the standard forms which may be bought in the open market. There are several methods of making bends by hand in addition to those for producing them by machinery. The method generally adopted consists of laying out a development of the bend. The different segments are then cut from this development, sufficient allowance being made for joining, and connected by one of the usual methods followed in sheet metal work. These methods are adequately treated in many textbooks on sheet metal pattern drafting. In the majority of engineering work shops, however, such books are not always available when they are needed and many a mechanic has been at a loss to know how to proceed to lay out an accurate pattern for a bend of the radius and angle desired. It is for the use of such men that the present article has been prepared, illustrating a simple method of making sheet metal bends—either single or double and of any radius—from sheet metal pipes, without the necessity of laying out the developments to obtain the patterns.

Bends are more easily made from pipes of thicker gage, as the stouter metal lends itself more readily to bending. Special machines are generally used in marine and locomotive engine shops, but where the number of bends is limited, simple methods are generally employed. In bending pipes, two preliminary steps are necessary, *i. e.*, filling the pipe with lead or rosin to prevent the formation of wrinkles and irregularities, and annealing the pipe at the point where it has to be bent. The lead or rosin is melted out of the pipe after the bending has been completed. Fine sand is sometimes used as a substitute for the rosin, the sand being confined in the pipe by wooden plugs during the bending operation.

Before entering upon a discussion of the production of bends from sheet metal pipe, it may not be out of place to outline briefly the method of producing such pipe. When the diameter of the pipe is known, the circumference is obtained by multiplying the given diameter by 3.1416 or $\frac{22}{7}$, additional allowance being made for the lap. The sheet metal may be most satisfactorily bent between bending rollers, but if such rollers are not available, a round iron bar will answer the purpose. The seam or joint is either soldered or grooved, according to the requirements of individual cases. Where the sheet metal is to be bent by hand, an iron bar is generally used, around which the metal is formed with a box-wood mallet, or an ordinary plumber's dresser can be used with equally good results. The dresser covers a larger area at each blow and is not so likely to make indendations in the work.

A complete right-angle bend is illustrated at *D* in the accompanying illustration. In starting to make a bend of this type, the pipe is marked at the point corresponding to the center of the bend at the side of the pipe that will be at the outside of the bend. Equal distances are then marked on each side of this point so that a total of five marks has been made over the section of pipe to be bent. These marks are drawn almost all the way around the pipe. A hacksaw or chisel is then used to cut along these lines, care being taken not to cut completely through the pipe but to leave small portions to hold it together at the inner side of the bend. The method of procedure will be readily understood by referring to the diagram shown at *A*. The pipe is then bent to the form shown at *C* and the openings are closed up by pieces of sheet metal of the shape shown at *B*. Sufficient allowance is made in the size of these pieces so that they lap over on both sides to allow for soldering them in place. As previously stated, five such pieces will be required in making a right-angle bend. After these pieces have been cut out, they are slightly hollowed or peened by hammering them on a concave wooden block. After this peening operation has been completed, the pieces are bent around the pipe and secured in place, thus forming the complete bend shown at *D*.

Obtuse, acute or reverse bends are made in exactly the same way. An obtuse-angle bend is shown at *E*, where it will be evident that the construction is exactly the same as previously described, except that it was only necessary to make three cuts in the pipe instead of five. In the case of acute-angle bends it will be necessary to make more than five cuts, the number varying according to the bend. Reverse bends are made in the same way except that the cuts for the reverse bend are made on the opposite side of the pipe from those for the first bend. An ordinary mechanic will be able to make very satisfactory bends by this method without having had any extensive experience in sheet metal work.

* * *

LUBRICATION OF AIR COMPRESSOR CYLINDERS

The following information relating to the lubrication of air compressor cylinders is given in a pamphlet issued by the Fidelity & Casualty Co. Recent disastrous explosions in air compressor systems indicate the danger existing from the use of ordinary engine oil in air cylinders. Only a pure mineral oil with a flash point as high as good lubricating qualities will permit, should be used. An excess amount of lubricant should be avoided. As air receivers are liable to explosion from accumulated oil deposits, every receiver should be equipped with a pressure gage, safety valve and proper drains. All reservoirs and pockets in the air line where there might be deposits, should be drained frequently and cleaned. It is bad practice to have the air compressor inlet in a hot or dusty room. The air should be as cool and clean as possible. The practice of throwing kerosene oil into the compressor inlet to clean it is extremely dangerous. Lubrication of the air cylinder with soapsuds (preferably made of one part soft soap to fifteen parts water) for a few hours each week or less frequently if the load is light, will aid materially in keeping the cylinder clean. To prevent rust, discard the soap and feed oil into the cylinder about an hour before shutting down. The receiver blow-off should then be opened and the accumulation of oil and water drained off.

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We solicit contributions from practical men on subjects pertaining to machine shop practice and machine design. All contributed matter published exclusively in MACHINERY is paid for at our regular space rates unless other terms are agreed on.

FEBRUARY, 1914

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"INVOLUTE" GEARS AND CUTTERS

The report of the American Society of Mechanical Engineers committee on involute gears rendered at the last spring meeting was disappointing, but the fact that the data of tooth shapes produced by the so-called "involute" gear cutters made by the various cutter manufacturers are held a close secret caused an indefinite report by the committee to be almost a foregone conclusion.

The fact that true involute curves are not produced by commercial cutters of the rotary type was not generally known until a very few years ago, and the knowledge is by no means widespread now. Gears cut by true involute cutters of the rotary type, made in sets of eight to cover all numbers of gear teeth from a twelve-tooth pinion to a rack, will not run together satisfactorily. In order to make the rotary cutter a commercial proposition it was necessary to limit the number of cutters required for a given pitch, but to do this, theoretical considerations had to be sacrificed in order to secure satisfactory interchangeability. Hence, the involute cutter is involute in name only. The real tooth shapes are empirical and were reached by experimentation.

The data of "standard" cutter shapes comprising the radii of the curves, positions of centers, points of intersection, and so forth, have been offered to MACHINERY for publication twice within a few years, but could not be accepted because they were submitted without authority. The contributors were not authorized to publish the matter by the concerns that had developed the shapes at heavy cost. But this scrupulous policy of MACHINERY has not been a bar to the dissemination of the data. Probably none of the rotary gear cutter makers need make their cutters by copying B. & S. cutters if they have been willing to "pay the price."

The situation is unfortunate in several respects. A premium has been placed on the dishonesty of trusted employes, the mechanical public has been misled and true interchangeability of gears cut with the cutters made by different manufacturers has not been realized. We believe that mechanical progress would have been fostered if the policy of secrecy as to the exact shapes produced had not been so rigidly adhered to. The correctness of the theory of involute gearing has been seriously questioned by mechanical men because of a misunderstanding of the situation. That the theory is correct, however, has been proved by the success of the generated involute teeth on spur, spiral and bevel gears.

In the interests of mechanical progress we suggest that the well-known "involute" gear cutter makers publish the data of tooth shapes used and thus bring about an agreement which will make for true interchangeability of milled tooth gearing and eliminate a mystery that is hardly creditable to American manufacturing policy.

* * *

RECORD OF PRESSED FITS

The paper presented before the American Society of Mechanical Engineers contributing the record of over two hundred pressed fits is of interest and value to machinists. No feature of machine shop practice, within narrow limits, of course, has been attended with more uncertainty than the over-size allowances to be made on shafts and crank-pins assembled with hubs by pressure. The length and thickness of the hub and the material affect the over-size allowance to be made. Many mechanics who never saw a micrometer were able to make pressed fits with no guide but "judgment" which, of course, was the result of experience, but most of them made excessive allowances compared with those recorded by Mr. MacGill. The result was often overstrained hubs that cracked in service.

Little is gained in tightness of fit by exceeding the elastic limit of the solid metal composing the hub, and serious damage will result if the overstrain is carried far. Rough turning and boring, however, permit of considerable apparent variation in practice. The ridges of metal on the parts are crushed in pressing together, and in crushing require much more pressure to assemble than to press apart. This is the test. The pressed fit which shows the least difference between the pressure required to assemble and to force apart, other things being equal, is the best.

* * *

"SAFETY ALWAYS"

The National Tube Co. is distributing a safety calendar which should serve a useful purpose in promoting the principles of safety in the operation of shops, mills, factories and in the ordinary affairs of life. No one needs to be told of the importance now attached to safety considerations nor how rapid the growth of the sentiment has been. Every general manager, superintendent and other responsible officer of concerns in states where compensation laws have been enacted is familiar with the new aspect of the safety movement and should feel that he is now his brother's keeper. The calendar mentioned bears twelve mottos of special application in steel mills, and of general application in manufacturing plants. Following are examples:

> Every danger sign posted in the mill means that the danger pointed out is real. Men must ascertain what is on these signs around places where they work and give heed to the warnings. The red ball on a sign means danger.
>
> It is better to be careful a thousand times than to be injured once. Get the safety habit. If you see a man acting carelessly tell him about it, and don't be afraid of hurting his feelings by doing so.
>
> Neglect of slight injuries often results in blood poisoning and serious trouble. The company has provided an emergency hospital, where employes injured in the mill can receive the best of attention. Don't neglect small injuries.
>
> Your eyes are valuable to you. Wear goggles when working where chips or sparks may fly. They may be awkward at first, but you will soon get used to them and then you wouldn't work without them.
>
> A dirty mill means accidents. Do not leave waste material or refuse lying around. Places are provided for keeping it. Do your part toward keeping the mill clean.

The mottos "Safety Always" and "Safety First" have become industrial slogans which must have some influence on the methods of older men and much on those of the younger ones. In the course of twenty years there will be an entirely changed attitude on the part of workmen generally in regard to accidents and accident prevention. A preventable accident will then be looked upon as little less than a crime on the part of the one responsible, and the intelligent employers of labor will have contributed greatly to the spread of the idea by enforcing rules for safe conduct of their employes similar to the foregoing.

WORK-HOLDING DEVICES AND TOOLS

The articles by Albert A. Dowd now running on work-holding devices, tools and tool-guides, for lathes and boring mills are unusual if not unique. So far as we know, nothing comparable with them has been published before. The importance of the subject is indicated by the large number and variety of means provided for holding work and performing circular machining processes.

The first and principal accessories for holding work for turning were, and still are, pointed centers. These and a driver constitute a perfect means for holding parts for cylindrical or taper turning or grinding. But they can be applied only when the work is of a shape that permits it to be mounted securely on conical points fitting into it. A narrow, thin ring cannot be held thus, and the primitive means provided was either a mandrel or a faceplate. The mandrel has its limitations as has also the faceplate. The latter fitted with bolts, clamps, straps and finally with movable jaws actuated by screws, became a chuck.

The lathe center, mandrel, faceplate or chuck appear in some shape or other in all forms of work-holders; but the variety of designs possible and necessary for efficient mounting and driving work in modern manufacturing plants is almost endless. To work out efficient designs independently requires wide experience and good judgment on the part of the tool designer.

It is not too much to say that no factor of production is more important than the mandrels and chucks provided for machines. The best machine tool must be inefficient if not provided with these in the variety and form required for the work to be done on it. Although so important, they have been neglected in many plants that outwardly present the appearance of being well equipped. A machine is only the mechanism for applying power to a tool for cutting or shaping. It is useless unless the tool and the holders for the work are provided. Thus three elements are necessary—the machine, the cutting or shaping tool and the work-holding device.

* * *

NEW MACHINERY AND TOOLS

Every period of business depression is marked by activity in the development of improved means of production. The reasons are not far to seek. First, there is an insistent demand for machines, tools and methods which will produce more cheaply. Manufacturers strive harder in dull times to produce goods at lower prices than when the demand for their products is heavy. Second, the builders of machinery have more time to improve their products and they take the opportunity to simplify and improve methods of production and to introduce new practices that cannot be given the necessary attention when the shop is running at top notch production.

The January number of MACHINERY contained twenty-eight pages of descriptions of thirty-two improved products in the machine shop and closely related fields. This showing is gratifying. It not only indicates that American machine tool builders possess great enterprise, but that they fully appreciate the advantages of showing their new products in a journal that maintains a liberal policy in regard to the publication of matters of news to the mechanical world. That this liberal policy means much to American machine tool manufacturers is becoming generally appreciated. In no case is exclusive publication required or even suggested. On the other hand, the editorial policy has always been to encourage simultaneous publication in all the mechanical journals. The new developments made by manufacturers in a given field are matters of news interest to the readers of the journals in that field. Manufacturers who support the technical press by their advertising patronage merit this recognition of new developments which they bring forth from time to time. The policy of exclusive publication of new developments in one journal only is selfish and even dangerous to the welfare of the industry both as regards readers and advertisers. It gives that journal a false standing and would permit monopoly in technical journalism to be established if carried to its logical conclusion.

FILING YOUR OWN PATENT*

BY FORD W. HARRIS†

It is an economical man who tries to cut his own hair, but it is probable that any of us marooned on a desert island and given a pair of shears would take an occasional "whack" at it. Similarly, an inventor ought not to be his own patent lawyer, but there are occasions, when stern necessity drives, on which any inventor is justified in trying it. This condition is often due to the fact that the inventor is unable to find the $65 demanded by a reputable attorney for securing a patent but can find the $15 fee charged by the government.

Before outlining just how an inventor goes about prosecuting his own case, it might be well to say a word or two about patent attorneys. It is a notorious fact that there are a great many incompetent patent lawyers. It is also a well-known fact that the average patent is valueless. The two conditions go together, being cause and effect. Some patents —in fact, most patents—are valueless because there is no real invention behind them. They are mere adaptations or improvements upon which no patent should have been allowed. The line between mechanical skill and invention is so indefinite, however, that our patent office has no choice but to grant a patent upon an application that discloses a novel structure or results and which can by any stretch of the imagination be considered an invention. Such a patent, however, has generally very limited claims and is of little value to anyone. The "shyster" lawyer is generally responsible for the existence of such a patent, as he has led the inventor to think he has a meritorious invention when he is morally certain that the invention is valueless. It is probable that some legislation looking to a tightening of the lines and excluding such trivial patents would drive many of the poorer patent lawyers out of business and save the inventors of the country a great deal of expense and many a disappointment. It is also probable that anything that would decrease the number and increase the professional honesty of patent lawyers as a class would have the same effect. Both of these reforms are urgently needed and no doubt will come.

Many patents are valueless, not because the inventor did not have a meritorious invention, but because he allowed a poor lawyer to give away his rights. There is nothing more pathetic than a good invention poorly protected. The inventor has disclosed his invention to the public, he has fully explained and illustrated it as required by law, and he has obtained in exchange a claim or collection of claims which is easily avoided or which will be declared invalid by the first court called upon to pass on it. This is almost always due to the laziness or incompetence of the attorney who handled the case. The patent office is generally fair, but it will not give an inventor any more than he asks for, and if his attorney is satisfied with poor claims, that is what he will get. It is, of course, sometimes possible to surrender such a poor patent and take a re-issue that adequately protects the invention; but the proceeding is difficult, involves additional expense, and must be done promptly. It is probable that raising the standard among the patent office examiners and the cultivation of a fairer viewpoint among them might assist in this matter, but the real remedy is fewer and better attorneys. Our patent system is the foundation upon which a great deal of our industrial prosperity rests, and the American people should make an earnest effort to correct the manifest abuses and graft that have sprung up in the patent soliciting business.

Any man having a real invention should exercise great care in committing it to the tender mercies of the average patent lawyer. The good lawyers are not hard to find. They generally have built up a reputation over a long period of years and are known to prominent attorneys, bankers and business men. Only such men should be employed on real inventions, and they charge little if any more than the

* For additional information on patent prosecuting and kindred subjects published in MACHINERY, see also: "Patent Experting—A New Field for Engineers," January, 1913; "A Patent Office Paradox," November, 1912; "Life and Cost of Patents," December, 1912; "Actual and Constructive Patent Infringement," April and May, 1912; "Proposed Changes in Patent Laws," July, 1912; "Patent Laws and the Cost of Manufacture," June, 1909; "Forfeiture of Patent Rights," December, 1908; "The State of the Patent Office," March, 1908; "Patents and Inventors," June, 1908.

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shysters. It often happens, however, that an inventor does not have the money to employ such a man and must abandon his invention or make a start at prosecuting it himself. Or it may happen that he has some experience in patent cases and does not value his invention highly enough to warrant employing an attorney. He can deal directly with the patent office, and though the old saying that "the man who doctors himself has a fool for a patient" is somewhat applicable, nevertheless it is probable that the average mechanic or business man could prosecute a case before the patent office with as good or better results than the shyster lawyer. In any case the following hints can do no inventor any harm, even if he has a lawyer.

In the first place, it should be recognized that the United States Patent Office gives an inventor a lot of latitude. It will send him, free of charge, a copy of the Rules of Practice governing the general conduct of its business and the inventor's relations to it. This book looks formidable, but really only the first twenty-eight pages and some of the forms interest an inventor on an ordinary application. If you cannot prosecute an application on this information you will find that the difficulties you meet with are unusual ones. In addition, every library has Walker, Robinson or Hopkins on Patents, and a few evenings spent in reading the opening chapters will give you an insight into patent theory that is well worth while.

Having mastered the general theory you can prepare your application. The first thing is the drawings. The Rules of Practice are very specific as to size, etc., and should be followed closely. Here again, the general spirit of fairness to an inventor is shown. The patent office will accept for examination any sort of a drawing that is plain, and will examine and act upon any application that contains such a drawing. Before the patent issues and is printed, however, drawings of the style specified in the Rules of Practice must be furnished by the inventor or he must pay the patent office for making them. But he can prosecute his patent to final allowance or rejection on drawings that are decidedly not in accordance with the rules.

Having made the drawings, the inventor must write his specification. A sample drawing faces page 68 of the Rules of Practice and the specification for it is given on pages 70, 71 and 72. Pages 12, 13 and 14 explain this specification and the general structure thereof, and it is not hard to prepare a reasonably good one. The petition and oath are given as Form 1 to 10 and Forms 18 and 19; they are plain and can be copied and filled in directly from the Rules of Practice. The inventor should be careful to fully show and clearly describe his invention, as new matter can not ordinarily be added to either the body of the specification or the drawing after it is once filed.

The specification ordinarily ends with one or more claims which to the ordinary mortal look like a mere jumble of words. They are a general, concise and exact description of the invention. In all the books on patents and patent law, there has been very little written about the form of claims that will assist an ordinary man in writing them. They are the patent, and it is in writing and changing them to make them allowable that the attorney earns his fee. Years ago, when the writer was an inventor and had never attempted to handle cases, he conceived a great awe for claims. They appeared to be wonderful examples of verbal gymnastics. After having prosecuted many cases for himself and others, the conviction grows upon him that they are mostly a trick. They are simply fundamental ideas wrapped up in verbiage. Some men apparently never learn to write them, others take to it naturally. The best advice I can give a prospective prosecutor is to go to the nearest public library and get a late copy of the Official Gazette of the United States Patent Office. Look through the single views and appended claims therein and pick out five or six patents that have a number of claims that you can understand. Preferably, pick those that are very short, for the fewer the words the better the claim. Send five cents in coin or money order for each patent to the Commissioner of Patents, Washington, specifying the number, date and name of the inventor of each, and you will get a complete copy of the drawings, specification and claims. Study the form and the way the claims are expressed.

If you have read Walker carefully you will know that you cannot claim a mode of operation, but only the means by which the mode of operation is carried out. You cannot use as an element in your claim "a shaft moving up and down," but you may say "a shaft, means for moving said shaft up and down," etc. Writing claims is a trick and the main thing to remember is that the more different things a claim may be imagined as describing the better it is. Avoid being definite. Say "means for fastening said pulley to said shaft," instead of saying "a tapered key." One way you may limit yourself to a simple tapered key and the other way you cover any means that may be used to fasten the parts together; for example, a set-screw or a tapered pin. Believe one who has tried it with good success that claims are not as hard to write as they look. The main thing is to claim enough. Ask broadly for everything in sight and say it as many ways as you can. A dozen claims are not too many.

Now wrap up your drawings, petition, oath, specification, claims and filing fee of $15 and send it to the Commissioner of Patents. Take your drawings to a blueprinter and get copies or the patent office will make them for you for 15 cents each. Then sit down and wait for from one to nine months for the patent office to act. The examiner may reject all your claims; he may object to your drawings as informal and tell you that before the patent is printed you must have others made; but he must give you reasons and he will tell you how to fix them. And when he does act, you have one year in which to answer him. And if you materially amend your claims by a letter to him you have another year after he answers you to answer him. And so long as you put in broad claims and stand by them, your rights cannot suffer. Patents may be kept pending for years in this way. The patent office is full of them. You have a year to answer the examiner every time and so long as you keep claiming the earth you cannot lose. But before you let the patent issue and as soon as you possibly can, get a good lawyer in on your patent and let him fix it up for you. Just consider how your hair would look if you cut it yourself and how you would miss an ear if your shears slipped.

* * *

Native copper is found extensively in the Lake Superior region, and with the exception of a few mines that produce arsenical copper, the "lake copper" is of remarkable purity. It is seldom found on the market at the present time, as most of it is contracted for by the makers of wire, sheet copper, etc. Most of the copper production of the United States does not come from "native copper" but from the ores of Montana and Arizona, which consist of copper and sulphur, or copper, iron and sulphur. These ores are usually roasted to remove a portion of the sulphur, arsenic and other volatile impurities. They are then smelted with coke in a vertical furnace, producing a matte or compound of sulphur, copper, and iron that may contain thirty per cent copper. This matte may be given a higher copper content in various ways, or it may be run into a Bessemer converter, the iron and sulphur burned off and the resulting coarse or crude copper, which may be 99 per cent pure, cast into anode plates and electrolytically refined. The resulting electrolytic copper is often superior in purity to lake copper. The less pure grades of electrolytic copper are known as "casting copper" and are sold for making brass castings and for uses where a high conductivity is not required.—*Mechanical World.*

* * *

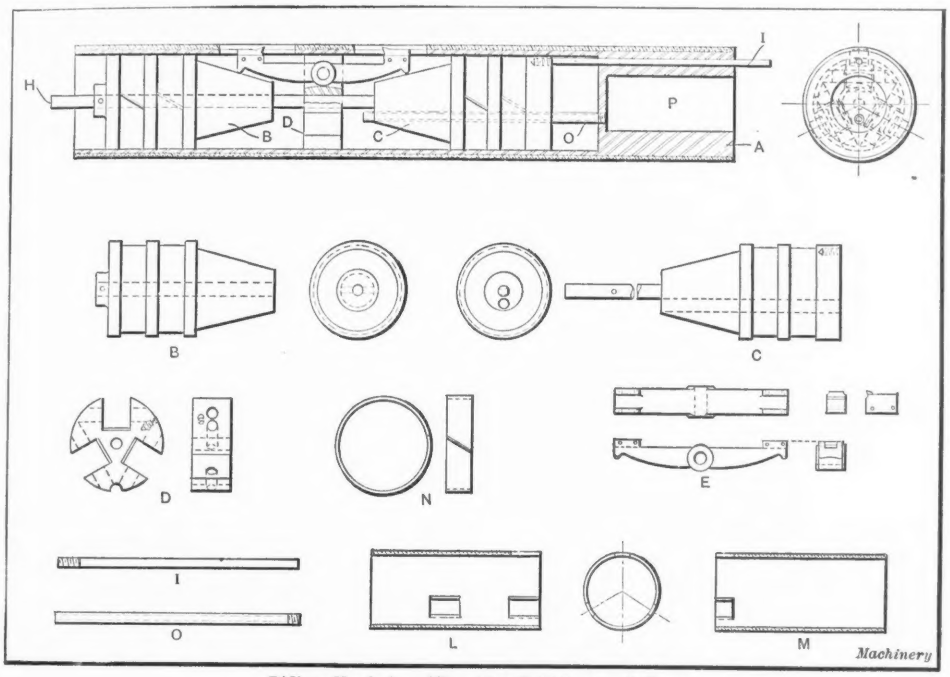
Machine tool builders suffer in some cases from the effects of jealousy or false pride which prevents them using the machine tools of competitors for work on which they are manifestly superior. If a special design of machine will do a certain class of work better and cheaper than the ordinary standard machine tools, the manufacturer—whatever his product may be—should be of a sufficiently liberal mind to adopt and use it in his shop. Of course, there may be honest disbelief in the value of a given machine for its express purpose, but in nine cases out of ten the disbelief is simply prejudice that will not be overcome.

RIFLING HEAD FOR RIFLING RECOIL VALVES AND GUNS

BY RUDOLPH R. GUENTHER*

The improved form of rifling head illustrated herewith has been used very successfully by a large eastern corporation for rifling recoil valves and guns. The outside diameter of the rifling head is about 0.002 or 0.003 inch less than the finished bore of the gun barrel, or recoil valve, and, as it is fed through the finished bore, three spiral grooves are cut, the finished depth of the grooves being 0.189 inch. The rifling head is connected at *P* to the bar of the rifling machine, and it is held in place by a steel pin. The machine used for this class of work is especially designed for the purpose, and measures about 60 feet in length. The bar to which the rifling head is attached has a travel of about 20 feet and is operated by means of a long worm screw which runs in a tail-head to which the rifling bar is attached.

The gun barrel or recoil valve to be rifled is held by means of a headstock and tailstock, which are geared so as to revolve the work at the proper ratio in order to generate the helical rifling grooves. The rifling head is equipped with a double set of tools, so that it cuts both the forward and return strokes. At each end of the machine there is a feeding mechanism which automatically withdraws the three cutters which have just completed a stroke, and moves the other set of three cutters outward for the return stroke. Each of these feeding mechanisms is composed of a worm, worm-wheel and ratchet wheel, to which a stop is attached; this stop engages the rifling head and is caused to move outward a certain distance for each stroke of the head, the movement depending upon the depth of the cut to be taken.



Rifling Head for rifling Recoil Valves and Guns

The construction of this rifling head is shown by the assembled and detailed views of the illustration. The casing *A* is made from a solid steel forging in order to secure a true bore and a perfect working fit. On the outside of this steel casing there are two sleeves *L* and *M*. These sleeves are made of bronze and forced on but are also held by small set-screws. Inside the steel casing *A*, two expansion heads *B* and *C* are located. Expansion head *C* has an extension rod which passes through a hole in the head *B* and the latter is attached to it by a small pin, thus locking the two expansion heads together.

The cutters are held in cutter-holders *E* which are pivoted in the center to a pivot bearing *D* which is slotted at three places 120 degrees apart, as shown by the detailed view. This pivot bearing is held in position by set-screws, and the outer ends of the cutter-holders are supported by conical surfaces on the expansion heads. Expansion head *C* has a hole directly under the central rod, which is provided for pipe *O*, through which oil is supplied to the center of the rifling head for washing out the chips at the end of each stroke and for keeping the cutters well lubricated. The oil also flows through a small recess cut in the bottom of pivot bearing *D*, into the space adjacent to head *B*.

Head *C* is provided with a rod *I* which is engaged by the stop of the feeding mechanism previously referred to, when the head is at the right end of its stroke. Similarly, end *H* of the extension rod engages the corresponding stop at the opposite end of the machine. In this way the expansion heads are moved either to the right or left, thus expanding one set of cutters outward and withdrawing the opposite set. Each head is equipped with cast-iron expansion rings *N*, which, by reason of the friction between the ring and casing, cause the rifling head to stay in the position in which it is set by the feed stops at the end of each stroke. The feeding mechanism is designed so as to feed the cutters outward at the beginning of each stroke not more than 0.0035; in other words, successive cuts of 0.0035 are taken until the grooves are machined to within about 0.0045 or 0.005 inch of the finished depth. The mechanism is then adjusted to throw out the cutters only 0.0015 inch, in order to prevent the tools from gouging into the grooves on the finishing cuts.

The rocker arms or cutter holders are made of forged steel and the outer ends beneath the cutters are shaped concave to fit the cones of the expansion heads. These conical ends of the heads were hardened and then ground and polished to insure a true working surface. The bearing ends of the cutter holders were also hardened to insure a perfect working fit and to reduce wear to a minimum. This improved rifling head has made it possible to rifle the bore of a gun barrel or recoil valve in about 56 per cent of the time required with the old-style head. With the latter, which was only equipped with one set of cutters, the time for rifling a recoil valve was about 55 hours, whereas with the improved head the same operation is performed in about 30 hours.

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* * *

EXPERIMENT WITH FALLING BODIES IN A DEEP MINE SHAFT

The Michigan College of Mines, Houghton, Mich., has made some interesting tests of falling bodies in a deep vertical shaft of a copper mine at Calumet, Mich. Within a radius of a mile from Calumet are three of the deepest shafts in the world, one of them being 5300 feet deep. One of the experiments consisted in dropping a smooth metal ball two inches diameter from the center of the shaft and trying to catch it in a box of clay placed 4200 feet beneath. Another ball was dropped from the southwest corner of the shaft. The balls were dropped by burning the threads by which they were suspended so that they started to fall directly downward. The shaft is nine by thirty feet cross-section. The first of the balls was suspended four feet from the side of the shaft and the second from a point nine feet from the opposite corner. Neither of the balls reached the box of clay; one of them was never found and the other, presumably the one started from the center, was found by a workman lodged in the timbers on the east side of the shaft 800 feet from the surface.

Bodies dropped into the shaft invariably lodge somewhere in the east wall. This action takes place because the earth is rotating on its axis from west to east. At Calumet a particle at the surface is moving to the east at the rate of about 1000 feet a second; but a particle 5000 feet down the shaft,

having the same angular velocity as the particle on the surface, is moving eastward at a rate of four inches less than 1000 feet per second. The ball suspended at the top of the shaft had a thousand-feet-a-second velocity; it was not only moving eastward at that rate when it started to fall but continued moving eastward all the way down the shaft. Meanwhile it dropped to the bottom at a rate which would have taken 17½ seconds for the fall if there had been no air resistance to encounter. During the 17½ seconds, the particle at the surface and the ball falling at the same rate would have traveled 17½ times four inches or nearly six feet further eastward than the particle at the bottom of the shaft. The ball started from the center of the shaft, therefore, struck the east wall long before it reached the bottom. As a matter of fact, the resistance of the air at the high speed the ball acquired soon after starting, was sufficient to prevent any further acceleration and consequently the ball was much longer than 17½ seconds in falling. In fact, only 800 feet of fall was required for the ball to make the four feet from the center of the shaft to the east wall and the other ball must have lodged at some point not much further down.

If the walls of the shaft were smooth and free from obstructions, no doubt a falling body would rebound from side to side of the shaft and finally reach bottom, but the many timbers in the lining of the shaft and the levels all the way down furnish places where a body is sure to lodge, and so if a load of ore were to be spilled into the shaft near the top most of it would later be found clinging to the shaft or stranded on the levels east of the shaft.

* * *

ROLLER AND SILENT CHAINS

At a recent meeting of the Society of Automobile Engineers, John R. Cautley presented a paper on roller and silent chains. A few general hints and practical suggestions contained in this paper are given in the following:

Many engineers have a distinct misconception as to all forms of driving chains. No roller or silent chain can be compared directly with belting. A driving chain is a piece of fine and highly accurate mechanism and should be treated as such. It will stand an amazing amount of abuse, but if properly installed and cared for it has an efficiency throughout its life which is hard to equal. Two basic principles in the design of a "standard" roller chain are: first, maximum wearing surface for the minimum of weight consistent with reasonable strength; second, such a proportion between roller diameter and sprocket tooth gap as will allow the maximum of wear on both with proper gearing.

Never use a tightening device on the back of a silent chain. An idler sprocket may be used, but it must start with at least three teeth in engagement. This is owing to the difference in mesh when the chain runs as a rack and when it runs over sprockets. If the chain runs over three wheels for any purpose, adjustment must be provided. Accuracy of chain and sprockets and mounting is just as necessary with both silent and roller chains as with gears, but this is easier to obtain with chains.

Means for adjustment is advisable for both kinds of chain and is often imperative. Suitable dust-proof cases improve the running of chains. Silent chains have drawn the attention of automobile engineers to the advantages of chain drive, but they should not overlook the modern and highly accurate roller chain which has many uses. An odd number of teeth is advisable for the small sprocket. This is not "a hunting tooth" but has the same effect with regard to the chain, as it prevents the same combination of links coming into mesh each time. Avoid an odd number of links where possible, as offset links, no matter how well made, are inherently weak. Small sprockets should be made of steel and should preferably be hardened, though this practice is not universal. For many purposes, sprockets of over forty-two teeth may be made of cast iron. Even with poor installation, chains hold up to their remarkably high initial efficiency until practically worn out.

* * *

Friction wears out machinery, and worry—not work—uses up men

MAKING SHRAPNEL CASES ON THE CLEVELAND AUTOMATIC

An unusual example of automatic machine work is that of producing the shrapnel case shown in Fig. 1. This case is made from a bar of 3 1/16-inch chrome-nickel steel stock. The steel has a tensile strength varying from 125,000 to 135,000 pounds per square inch, and is extremely tough. The work

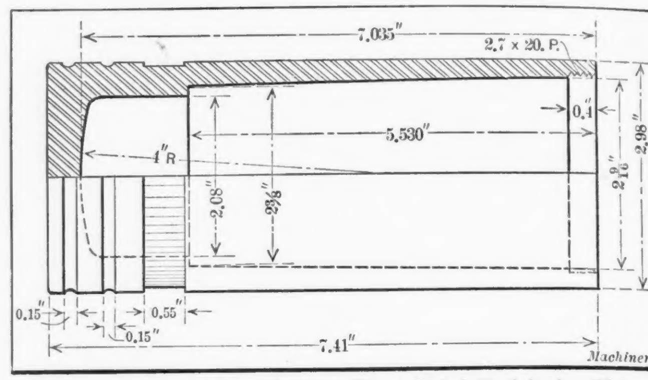

Fig. 1. Shrapnel Case made from Chrome-Nickel Steel having High Tensile Strength on a Cleveland Automatic Screw Machine, made by Cleveland Automatic Machine Company, Cleveland

is accomplished on a 3¼-inch Cleveland automatic, and the tooling equipment, as shown in Figs. 2, 3 and 4, is interesting. While the general operation of the Cleveland automatic is well understood by many mechanics, the production of this piece illustrates a number of points in the operation of this machine which are not so well known. Therefore it is

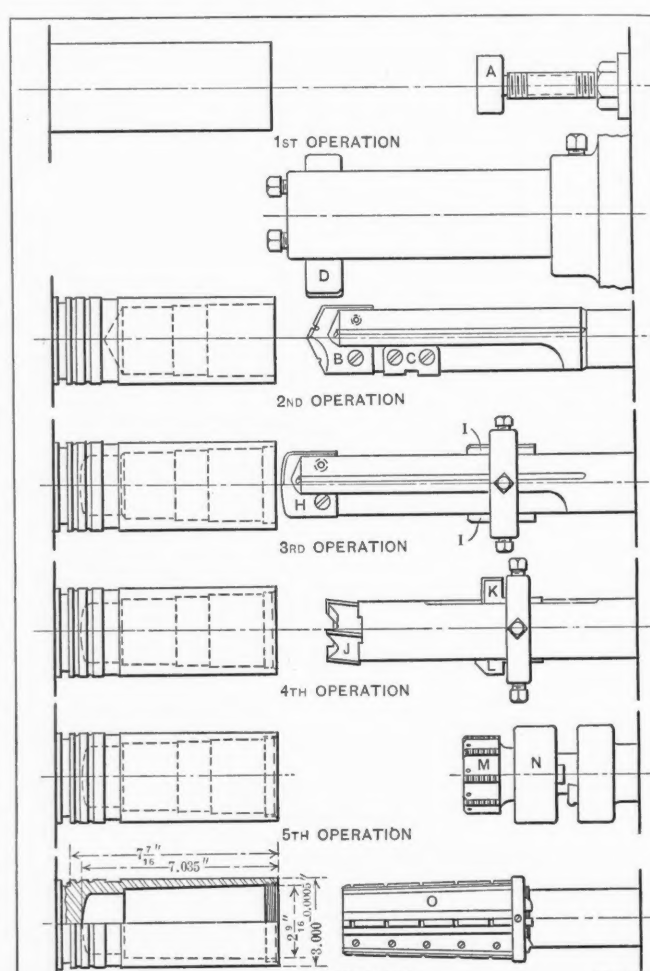

Fig. 2. Order of Operations on the Shrapnel Case

advisable to explain in detail just how this interesting job is handled.

The first operation, as the job was originally laid out, was to feed the stock out to the stop *A*, shown in Fig. 3, which is held on the cross-slide and operated by a lever on the base of the machine. This method, since the photograph shown in Fig. 3 was taken, has been improved upon and the time

cut from twenty-seven and one-half minutes to twenty-five minutes (see Fig. 2 for improved method). The second operation is to rough-drill the large hole with an inserted bit *B*, step the hole for the taper reamer with cutter *C* and rough-turn the external diameter with cutter *D* held in a special turning attachment. This attachment envelops the shanks of all six tools in the turret in order to obtain support. The cutters in the attachment shown in Fig. 3 work in advance of the under-cutting forming tool *E* shown in Fig.

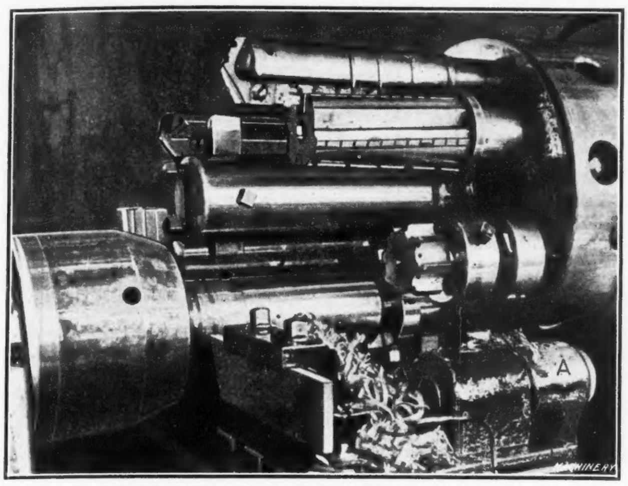

Fig. 3. Cleveland 3¼-inch Automatic Screw Machine set up for making a Shrapnel Case in Twenty-five Minutes

4, which is held on the rear cross-slide. The time required for the completion of the operations outlined is thirteen minutes.

In the third operation drill *H* finishes the powder pocket, and two cutters *I* counterbore for the tap—time required three minutes. The fourth operation consists in finishing the diaphragm seat with the counterbore *J*, finishing the face end with inserted cutter *K* and breaking the corner to facilitate tapping with inserted cutter *L*, the time required being forty-five seconds. In the fifth operation the thread is cut with a tap *M* held in the tap-holder *N* in forty-five seconds. Then the turret is indexed and for the sixth operation the hole is taper-reamed with reamer *O* provided with four inserted "Novo" steel blades, in ninety seconds. The last and seventh operation consists in knurling the band with a knurl *P* (see Fig. 4) mounted on the front cross-slide, and cutting the shell off with a cut-off blade *Q* retained in a holder on the rear cross-slide—time six minutes. The total time required to produce this shrapnel case by the improved methods illustrated by the diagram in Fig. 2 is twenty-five minutes.

There are several points of unusual interest in the production of this shrapnel case. One is the large amount of stock to be removed to form the hole; the second is the long taper-reaming operation—difficult work to accomplish satisfactorily on an automatic screw machine—and the third is the long outside forming operation which must be held to a limit of 0.0005 inch on the diameter. In order to accomplish this last operation successfully, the external diameter of the piece is first turned with a cutter held in a separate turning attachment, leaving only 0.010 inch on the diameter to be removed by a wide under-cutting or shaving tool *E* held very rigidly on the rear cross-slide. Not only must the case be exact as regards diameter, but it must not vary from one end to the other nor at any point throughout its length. The large shaving tool held rigidly in the manner illustrated in Fig. 4 accomplishes this result satisfactorily.

The material from which the case is made is so tough that some difficulty was met with in selecting a tool steel that would stand up for a reasonable length of time under cut. The drills and counterbores are tipped with "Novo" cutters and all the forming tools, including the cut-off tool, are also made from the same steel. The only cutting tool in the entire tooling equipment not made of this steel is the tap. The bar is rotated at sixty-four revolutions per minute, giving a surface speed for the external cutting tools of approximately fifty-one surface feet per minute. The low cost of production of this shrapnel case is remarkable. Although the material is difficult to work, the labor cost for each piece is only 0.041 cent—almost negligible as compared with the cost when made by hand-operated machine methods. D. T. H.

* * *

The Russian torpedo-destroyer *Novik*, on the official trial run, reached a mean speed of 37 knots and a maximum speed of 37.3 knots. Several days afterward the vessel underwent the continuous six hours trial provided by contract. The speed of 36 knots prescribed for this trial was not only reached, but exceeded considerably, a mean speed of 36.2 knots throughout the six hours, and a mean speed of 36.8 knots during the last three hours being obtained. The *Novik* is a turbine-propelled vessel of 1280 tons displacement, and the boilers are fired with liquid fuel.

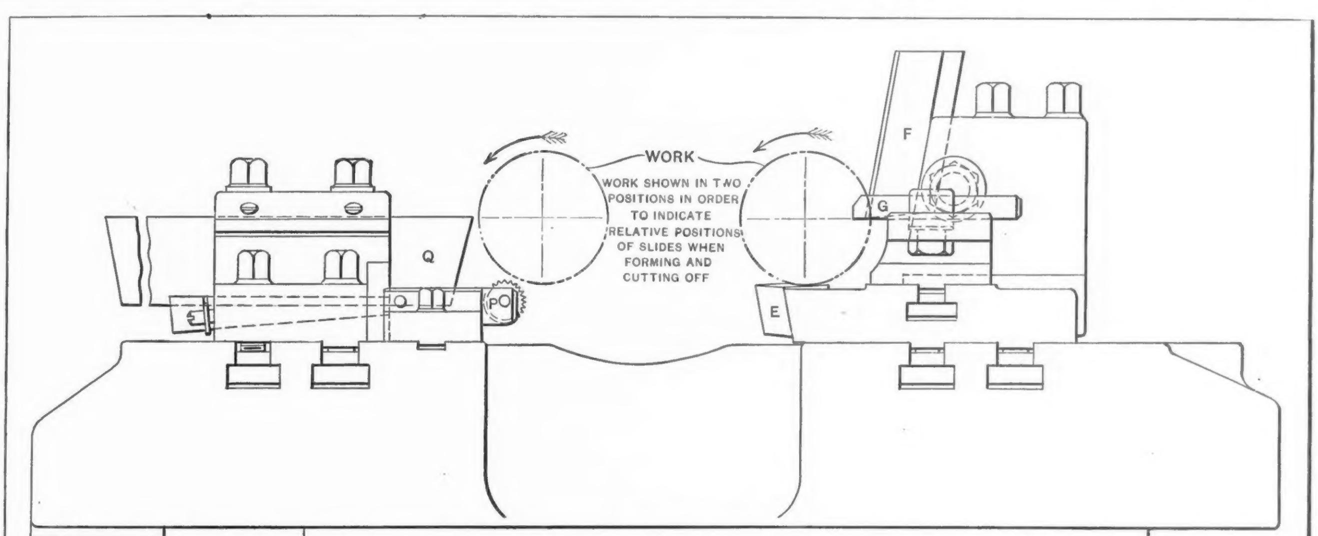

Fig. 4. Showing Tools held on the Front and Rear Cross-slides for performing the Knurling, Forming and Cutting-off Operations on the Shrapnel Case

LUBRICATING SYSTEMS FOR CUTTING TOOLS—2

METHODS OF DRAWING LUBRICANT—DESIGNS OF DRAINAGE PANS AND TANKS—SEPARATION OF CHIPS AND LUBRICANT

BY JOSEPH G. HORNER*

The cutting tools which require a supply of lubricant through their hollow bodies include drills, reamers, counterbores, boring tools, and, less frequently, taps. Threading dies

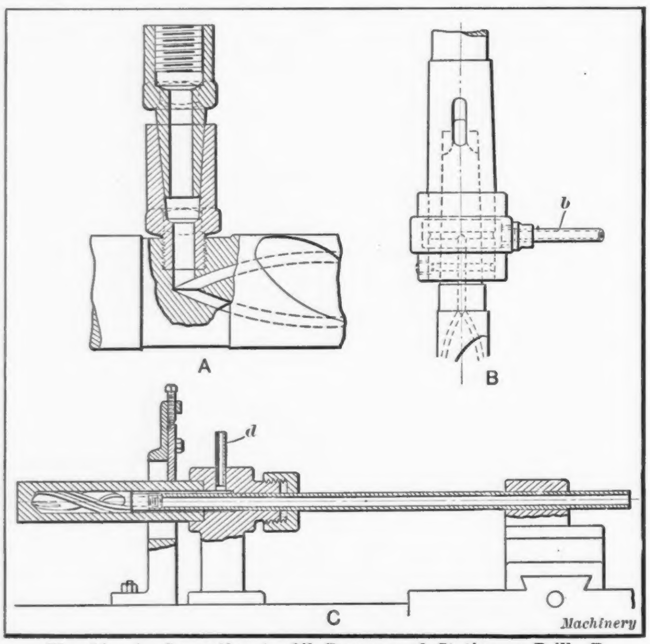

Fig. 11. A, Connection to Oil Passages of Stationary Drill; B, Connection to Oil Passages of Rotating Drill; C, Method of lubricating Hollow Drill for Deep Hole Work

are also fed by a pipe which floods their interior, or the threading machine may have a hollow spindle through which the oil is pumped. Long drills or their separate holders, not held

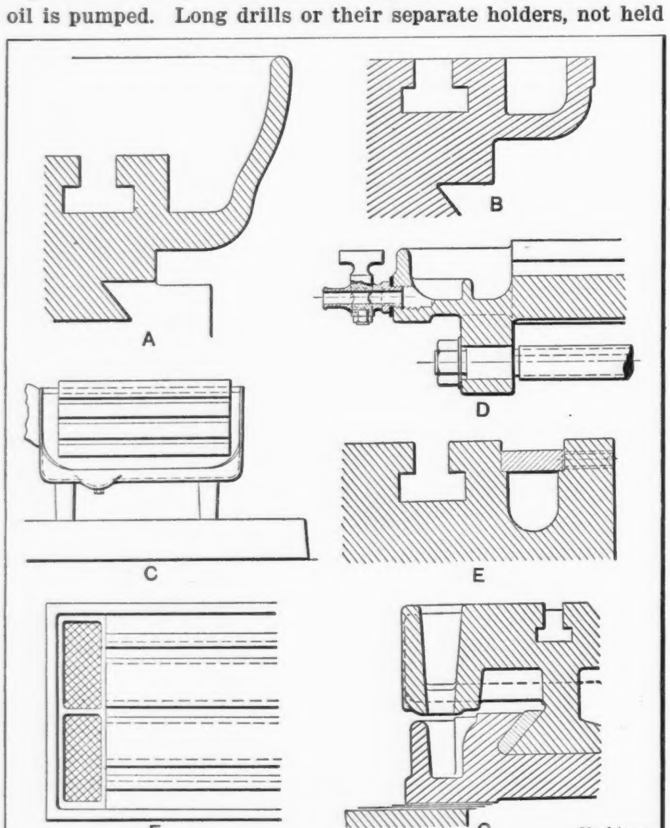

Fig. 12. Various Forms of Drainage Channels for Machine Tables

in a turret, usually have the supply pipe screwed in at the end and the oil goes to the cutting end by way of open grooves or grooves covered with strips soldered over; sometimes holes are drilled in the solid metal to the cutting point, or pipes are laid in recesses along the body of the tool. If the oil is not taken through the end of the drill it may be supplied as shown at *A*, Fig. 11. This method is suitable for any class of drilling machine or turret lathe in which the drill does not rotate. Connection to a flexible tube enables the drill to feed along to any desired extent.

A modification in the form of a loose collar, as at *B*, is necessary to permit a drill to revolve. The collar is held from revolving by the supply pipe *b*. The oil is sometimes fed by gravity but it should preferably be pumped through; it passes to the passages which communicate with the holes or tubes of the drill. A cup-shaped collar is sometimes used, the oil being poured in from the top. In all these tools, the chips find their way out of the hole by the flutes or spaces of the tool, but in the hollow drills used for deep holes, they have a special outlet. The oil is fed by way of the body grooves, and the cuttings escape through the flutes, the hollow shank and an extension tube (see sectional view *C*, Fig. 11). A stuffing-box surrounds the tube and the oil is pumped through pipe *d*, and goes along the outside of the tube and past the shallow flutes on the lands of the drill. The oil then forces the chips

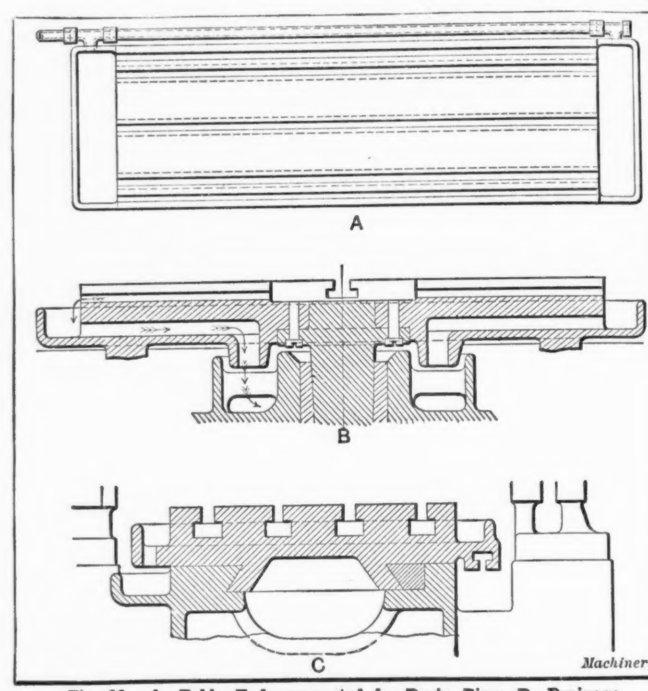

Fig. 13. A, Table Ends connected by Drain Pipe; B, Drainage leading to Annular Channel beneath; C, Drainage Channel for Reciprocating Table

back through the main flutes and out through the shank and the tube. The hole must be first drilled to a depth equal to the body length of the drill, before the latter can be used with

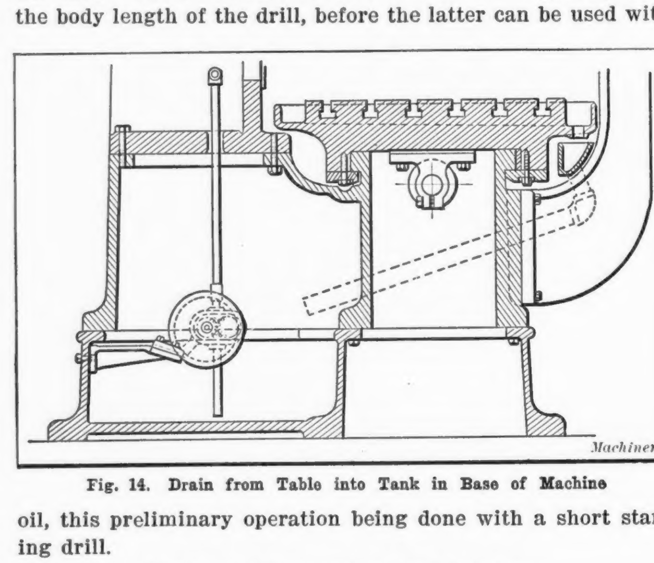

Fig. 14. Drain from Table into Tank in Base of Machine

oil, this preliminary operation being done with a short starting drill.

Methods of Recovering Used Lubricant

The methods of catching, draining and returning the oil are simple on some of the smaller machines, but more compli-

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cated on the larger ones, particularly on types which use lubricant very freely. The provision for lubricant often affects the design of the frame and many of the smaller details. The simplest catching device is a can hung underneath a table, this being emptied into the drip-can overhead at intervals. This is quite satisfactory when the quantity of lubricant used is very small, but like the drip-can, it fails to meet requirements when a flow of any magnitude is required, and a proper tank must be employed. The three principal means of receiving waste lubricant are, by a suspended tank, a tank on the floor or bolted to the machine base, or by using the hollow base of the machine to form a tank. The pans which surround the bases of so many machines come under the second category. The suspended tank is objectionable only on account of its limited capacity; the second class can be made of any desired dimensions; the tank in the base is a means of profitably utilizing the interior space, thus making it unnecessary to provide a separate receptacle.

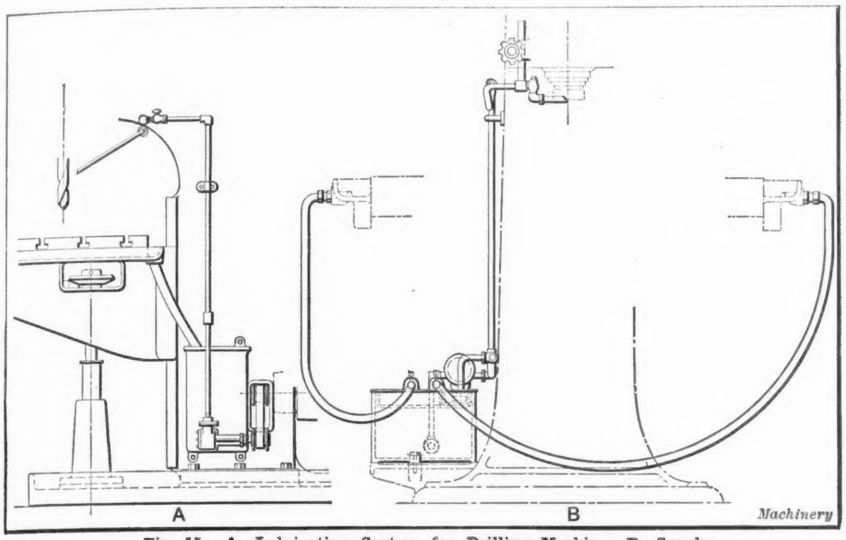


Fig. 15. A, Lubricating System for Drilling Machine; B, Supply and Return System of Vertical Milling Machine

The simplest method of dealing with the question of waste lubricant will be to follow the lubricant in its course, from the point where it leaves the work. It is also necessary to take into consideration the provisions for dealing with chips, since these affect the matter vitally.

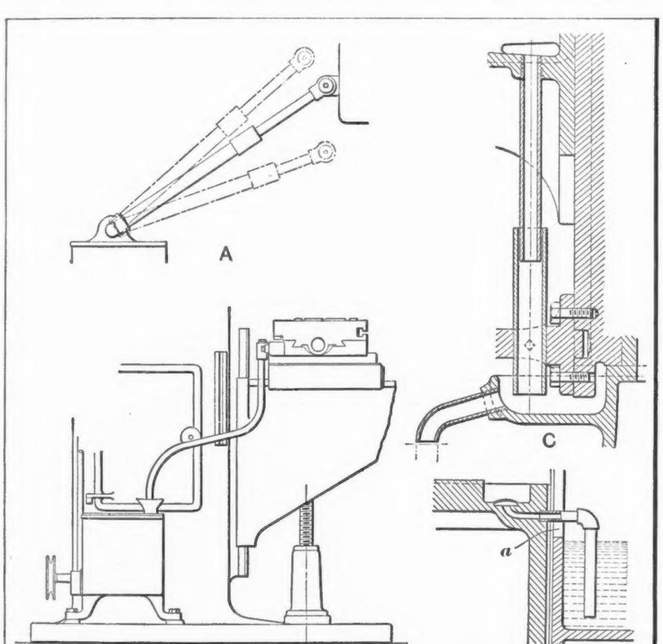


Fig. 16. Drainage Connections to permit Vertical Adjustment of Work Table

All work which is machined is held either on or over a table, or it may project beyond the bed or slide. In the first case, the table receives the waste oil, in the second, the oil either falls directly into a trough or is caught and diverted in various ways. Tables, when not intended for use with oil, simply have slots or tee-slots, and there is no rim or other provision to prevent a lubricant from falling onto the floor. The addition of a turned-up rim prevents the lubricant from escaping, excepting by the way of a spout or a hole, whence it drains into a can hung under the spout or tap, or falls through a rigid or flexible pipe, or by way of rims on subsidiary slides, to a tank below. The height of the rim is limited, in the majority of cases, by the level of the table, the rim being just below the table, but there are some exceptions. When it is known that the size of work or of jigs or fixtures will never exceed the bounds of the tee-slotted surface, then it is possible to raise the rim as shown at *A* in Fig. 12. This high rim is desirable when splashing is likely to occur. It is the practice now, with a great many milling machine manufacturers, to machine the oil rim flush with the table top as at *B*, in order that it may be utilized as a support and form part of the table surface. Large fixtures which hang over the working surface can thus be held, and dividing heads can also be set further apart than on a table with the rim set below. If a table having a vertical face, in addition to the horizontal top face, has to be drained, the oil rim is cast as shown at *C*, which is the table of a radial drill. The channel follows around the table and has a small well at the bottom, into which the waste collects and is drawn off by a tap or pipe.

Draining the Lubricant to the Supply Tank

The end of the table is the place most commonly selected for drawing off the lubricant, because it is more convenient to apply or attach a can, or to connect a pipe. The sectional view *D*, Fig. 12, shows the end of a milling machine table,

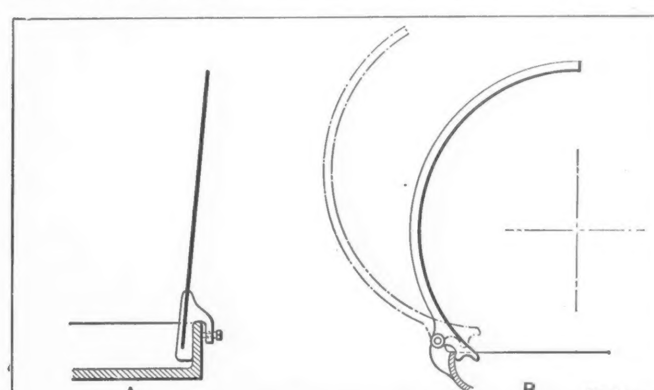


Fig. 17. Detachable and Pivoted Splash Guards or Plates

with a draw-off tap and an enclosure adjacent to the hole to prevent chips from blocking up the tap. Another device to prevent choking, which impedes the proper flow of the lubricant, is to fit guard strips to the channels, as at *E*, so that they cannot be quickly clogged with chips and thus cause table flooding. The filling up of the end pockets with chips is avoided on some tables by the use of removable strainer plates,

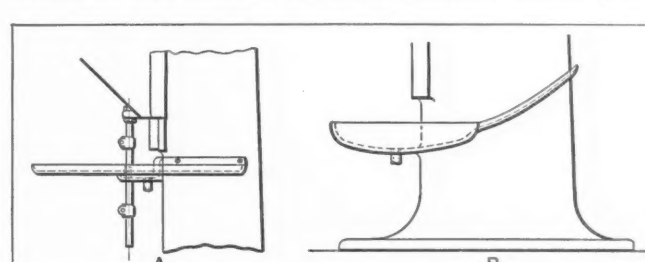


Fig. 18. A, Lubricant Tray attached to Column; B, Lubricant Tray cast integral with Column

as at *F*, which shows a plan view. These plates are set at about one-half the channel depth so that there is a clear space beneath for the liquid. In the milling machines made by

Messrs. D. & J. Tullis Ltd. of Clydebank (Scotland), the end pockets are connected by a pipe (*A*, Fig. 13), instead of having a deep channel on each side of the tee-slotted surface, comparatively shallow grooves being milled in the top to conduct the waste to the pockets.

When a square or a circular table has to make complete revolutions, the waste is preferably drained through the center into a tank or a hollow bed, the alternative to this being chutes leading to the main tank have to be used. If a table or slide has a limited range of travel in relation to some part below it, the part below can, in certain instances, be utilized as an intermediate drain. The section *G*, Fig. 12, of a milling machine table and slide, is an illustration. When, as in large plano-miller tables, there is no other moving part, arrangements have to be made to receive the oil at any longitudinal position. This is done by casting or bolting a trough

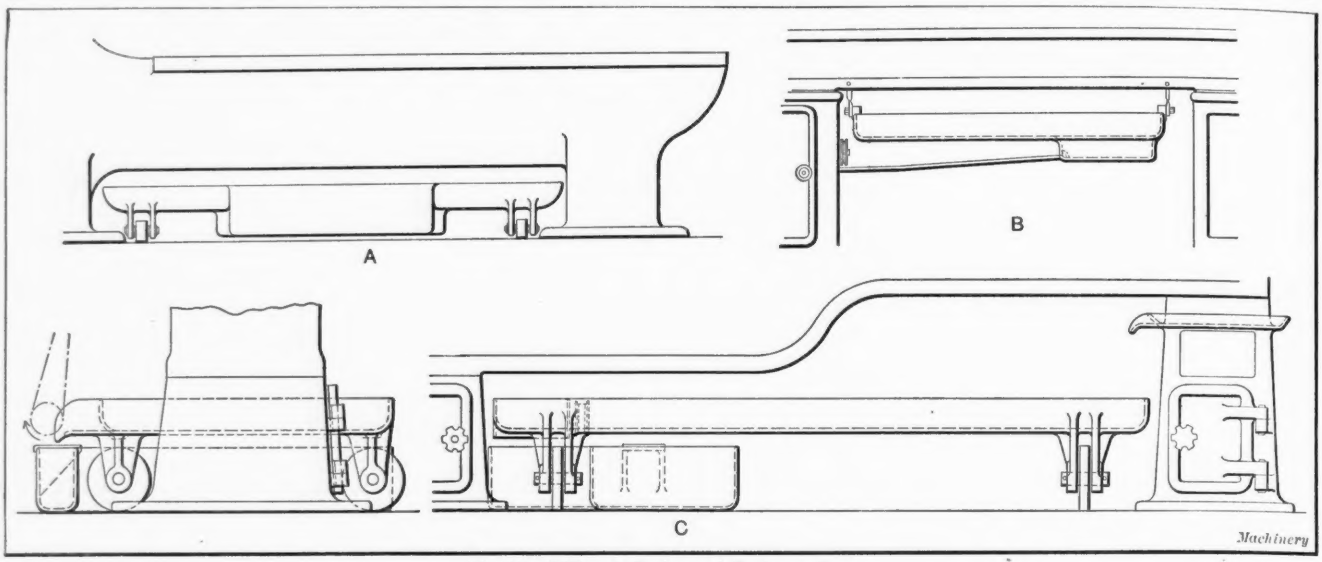


Fig. 19. Different Designs of Drainage Pans

to surround the table with a fixed pan into which the oil drips and is drained therefrom through a channel into a receptacle below. In the central drainage system, the precise course of the oil ducts depends on the manner in which the table is mounted. If there is no central spindle, but merely a hollow boss, the oil can flow down through this, but if a solid spindle occupies the center, the drainage takes place through passages situated some distance out, as at *B*, Fig. 13, to the side of the bed, just below the overhanging drain hole or spout of the table, and locating the drain hole in such a position that it will never run past the lower trough. The oil drains from the latter into a tank or hollow bed. A typical arrangement is shown at *C*, Fig. 13, and also in Fig. 14 (from a Walcott rack cutter), which includes the drain pipe from the trough into the hollow base and the pump and suction pipe.

Flexible tubing is employed very largely for drainage pur-

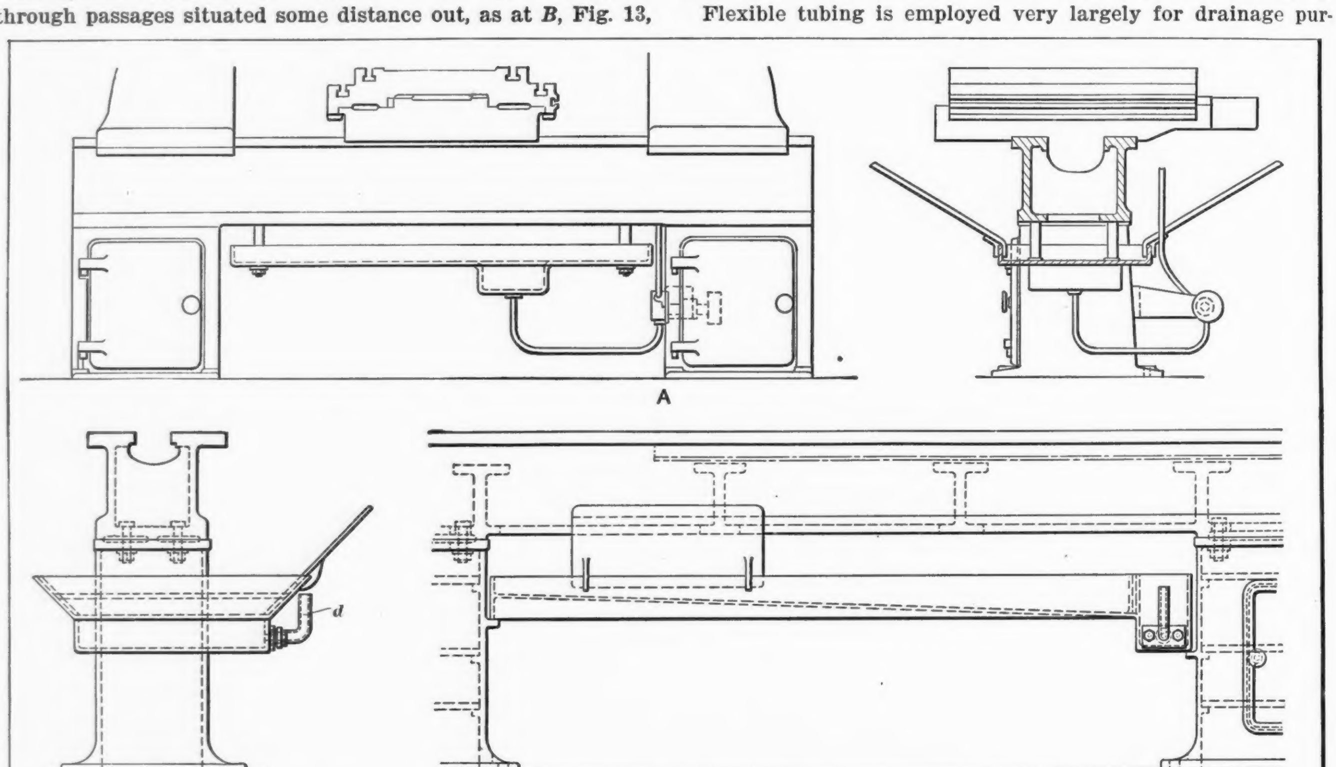


Fig. 20. A, Suspended Pan with Splash Guards; B, Pan beneath Lathe Bed, having Splash Guards and Well

which shows a gear-hobbing machine table. The oil falls into a rimmed enclosure and thence through apertures which lead down to a tank between the slideways.

The location of a spout or lip, when no pipe is connected, must depend upon the facilities for catching and the opportunities for maintaining the lip always over some portion of the pan or other receptacle. Frequently, it is impracticable to insure the latter condition, and then piping, or special poses. The only objection to it (beyond that of possible choking if of too small a bore) is that it gets in the way of the operator, on some machines, especially when the movements are of considerable range and therefore necessitate long pieces of tubing. In a case like the one illustrated at *A*, in Fig. 15, there is no inconvenience, because the tube is short and close to the frame, but at *B*, which shows an Alfred Herbert, Ltd., vertical milling machine the tubes are of necessity

long and somewhat cumbersome. Some of this firm's horizontal machines have a telescopic arrangement of piping extending from the cross-slide on the knee to the tank alongside the frame (as shown at *A*, Fig. 16), which accommodates itself to the vertical and horizontal positions of the slide, and takes the place of a flexible connection. The lower view *B* shows how a flexible drain tube is applied under similar circumstances, this example being from French practice. A slide with vertical movements can be drained by pipes, as represented at *C*. These pipes are telescoping and the lower one conducts the oil to a pan from which an outlet leads to the tank. Section *D* illustrates the drainage into the hollow frame of a drilling machine. There is a slot *a* of sufficient length to permit the pipe to travel up to the limit of the table adjustment.

Guards and Splash-plates

Two other details which are required for many types of machines are the guards and splash-plates which prevent the oil from flying beyond the limits of the machine or drainage pan. These devices are necessary chiefly for work rotating rapidly and comprise curved plates or castings around chucks

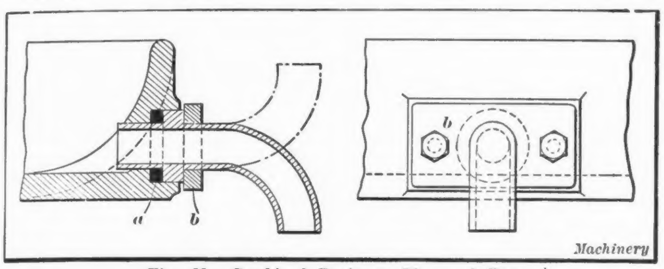


Fig. 21. Combined Drainage Pipe and Tap

and parts of spindles as well as around rotating work, and flat or curved plates held opposite the spindles or work, at some distance, so as to deflect the waste down into the pan. Sometimes drills are also encircled by sheet guards to catch the oil thrown off by the curling chips. All these types of guards are usually removable to facilitate the work of the operator, and are either clipped to convenient places or hinged to swing back. A clip for holding a flat guard is shown at *A*,

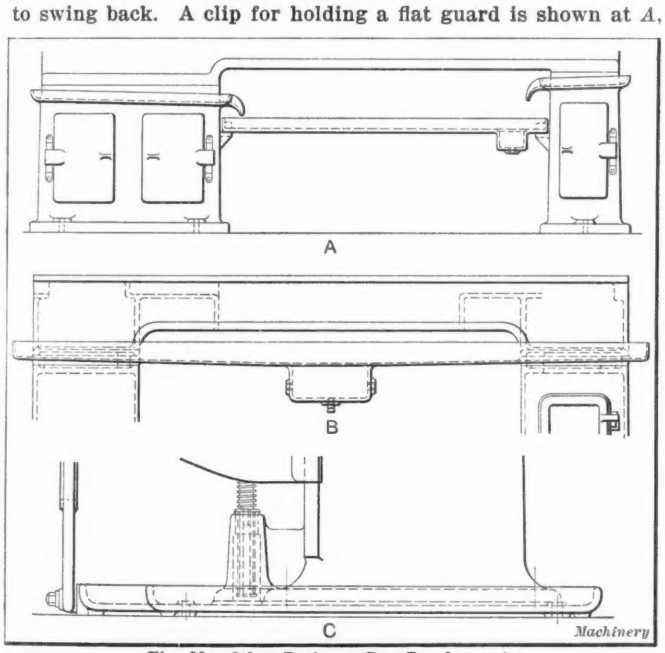


Fig. 22. Other Drainage Pan Developments

Fig. 17. This is also a convenient device for holding curved pieces to fit around the angles of a pan or base, instead of riveting the clips permanently to the splash-plate. At *B* is represented a hinged guard for protecting the whole of an automatic screw machine head, two of these being used. They can be swung down below the pan for inspecting the head. Hinged guards are also fitted around the tables of boring and turning mills, when lubricant must be used and the speed of rotation is rather high.

Drainage Pans for Cutting Lubricant

The nature and capacity of the drainage channels and drip-pans on any machine, depend both on the quantity of lubricant which is likely to be employed and the course which it takes after leaving the tools and work. Lubricant which does not escape from the bounds of a table and is caught immediately by a pipe, or other means, does not, of course, require channels or pans for collecting it; but if there is extensive splashing, catching-lips, trays, or regular pans become essential, until, in the final development, the whole machine stands in a large pan having deep sides. With a minimum of splash-

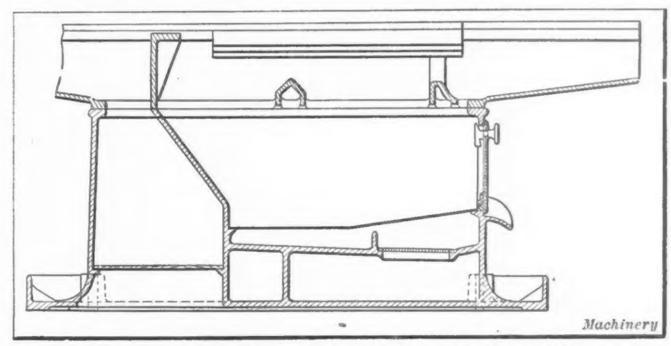
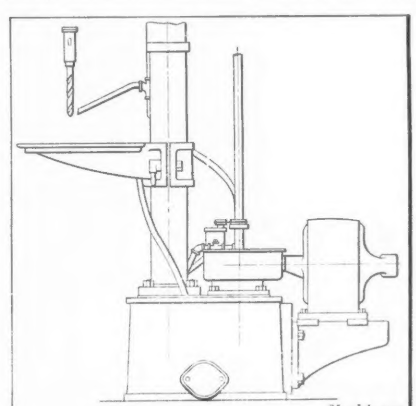


Fig. 23. Hollow Base of Turret Lathe used for receiving Chips and Lubricant—Tool Cupboard at Left

ing or dripping, which causes a small amount of oil or suds to trickle down the frame of a machine, a simple tray screwed on (as at *A*, Fig. 18) is sufficient, or the column may be completely encircled with a channel, as at *B*, the depth being increased at the front to hold a moderate quantity of oil.

A portable pan is often attached to a portion of a machine beneath the area of operation to receive the chips and lubricant, the latter draining through a pipe and away. Portable



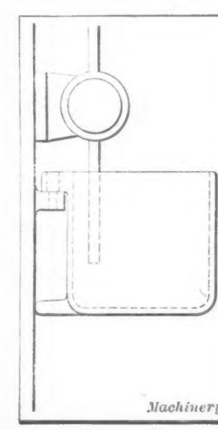


Fig. 24. Base of Drilling Machine used for Lubricant Tank
Fig. 25. Tank suspended on Lugs to permit Easy Removal for Cleaning

trays are also used on some boring and milling machines; these are placed under particular locations where lubricant drips down, and a flexible pipe connects the tray to the tank. A few examples of different arrangements of pans are given in succeeding illustrations. The detail *A*, Fig. 19, shows a portable pan with a well combined; illustration *C* shows another portable pan which has a separate tank that is fixed

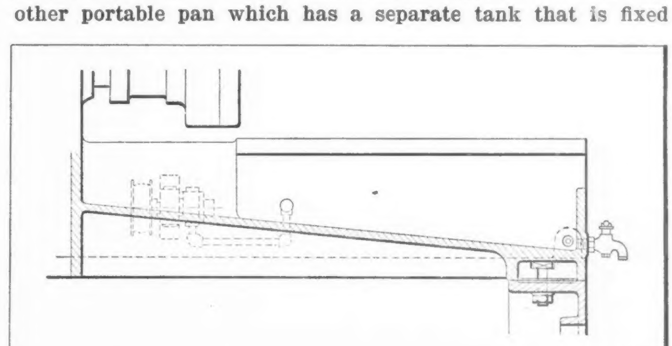


Fig. 26. Threading Machine with Tank Bed

and carries the pump. The portable pan has a lip, as shown in the end view, to drain into the tank beneath. The right-hand cabinet leg has a channel surrounding it which drains into the portable pan. For dealing with large quantities of chips, the pan on wheels is preferable to the fixed pan from which the chips have to be removed and transferred to some

other receptacle for disposal. At *B*, Fig. 19, is shown a fixed pan that is suspended beneath the machine. This practice is common in Germany because it enables pans to be added only when required, leaving the machine otherwise suitable for op-

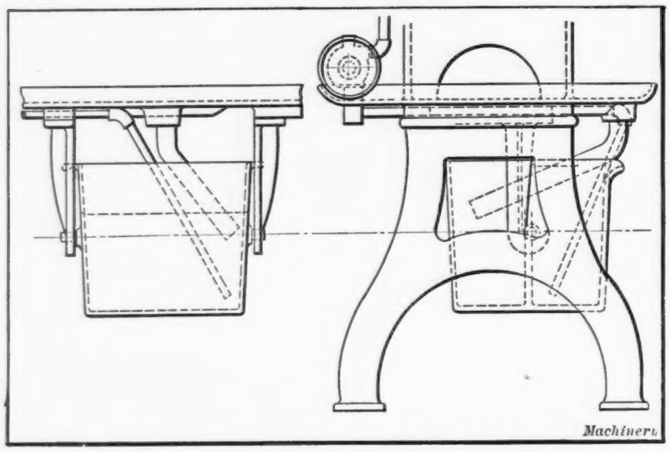


Fig. 27. Lubricant Tank suspended on Hooks for Tilting

eration without cutting lubricant. Another suspended pan (on a Greenwood & Batley special milling machine) is shown at *A*, in Fig. 20. This pan is hung on four bolts and has plates to catch the drip from the overhanging table. A pan with splash-plate attached is shown at *B*. This pan is supported on lugs cast on the cabinet legs and has a well and drainage

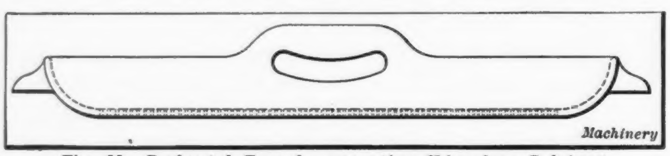


Fig. 28. Perforated Tray for separating Chips from Lubricant

pipe *d*. The method of fitting a pipe of this kind is shown in Fig. 21. It has a packing ring *a*, which is clamped by the shoulder of the bent pipe; the latter is held in by the gland plate *b*. In the position indicated, the pipe drains off the contents of the pan, but when turned vertically, as shown by the dotted lines, it retains the lubricant in the pan, forming a simple tap or drainage cock.

A further development is shown at *A*, Fig. 22, the drainage system including channels around each leg, so that no oil can escape, excepting into the pan; in a more complete system, the whole bed stands in a pan interposed between it and the legs, as at *B*. This is common practice with some classes of small milling and other machines which rest upon a floor stand, and with the smaller automatic screw machines. The larger ones either have a turned-up foot all around the base, or the whole machine stands in a large tray which is partly filled with lubricant, the depth of the tray ranging from a few inches to a foot or more. Milling machines standing in a separate tray, as at *C*, do not require such a large oil capacity as "automatics," especially of the multi-spindle type. The latter often have a hollow cabinet leg which contains an extra oil supply. Supplementary sloping chutes overhang the edges of the trays of some automatics to receive drippings from projecting turret slides and spindle ends.

The practice of receiving all the chips and lubricant entirely within the bed is noticeable in the Pittler (German) turret lathes (Fig. 23). The interior has a plate and grid to catch and drain the chips and there is a door at the end for their removal. The vessel to contain the chips is placed under the drainage lip by the door. The remaining portion of the machine frame, to the left, forms a tool cupboard. This utilization of the interior of the machine base to hold the oil, in order to avoid the provision of an outside tank, is a practice becoming increasingly popular. The bases of drilling machines (see Fig. 24), milling machines, gear-cutters, etc., often form excellent tanks for the reception of cutting lubricant. The chief objection with some designs is the difficulty of cleaning the tank. If the chips cannot enter the hollow body, this objection is negligible, but if they are free to fall in with the oil (as in Fig. 26), the chips become a nuisance. For this reason, special facilities are afforded for cleaning the tanks from which pumps draw their supply, in

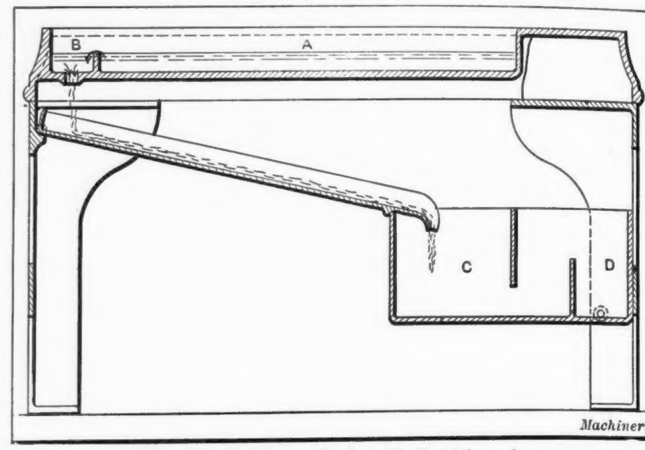


Fig. 29. Lubricant Tank with Partitions for separating Fine Chips from Lubricant

cases where the chips are fine and difficult to keep back. A tank, instead of being bolted down, may be hooked over a pin standing up from a lug (Fig. 25), without interfering with the pipes, or it may be tilted on lugs (Fig. 27). The tanks for Lincoln millers are often suspended in this way.

Separation of Chips and Lubricant

The separation of chips presents little difficulty, when they are large and cannot possibly pass through a small opening which admits the lubricant; but when they are fine, like the small chips from threading machines, etc., and particularly

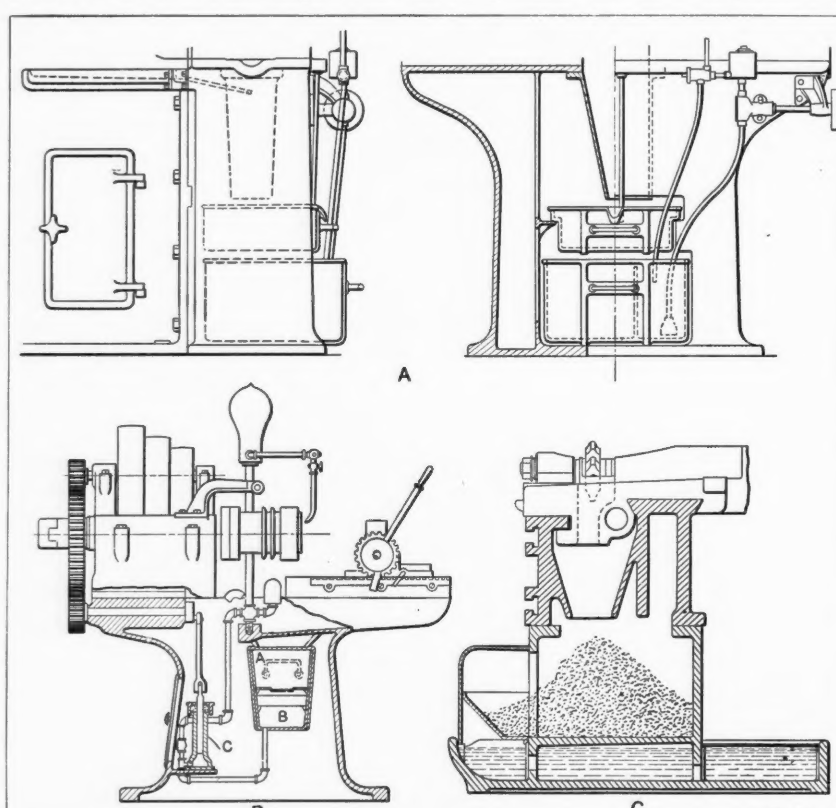


Fig. 30. A, Drainage Tank placed above Main Supply Tank; B, Common Lubricating Arrangement for Threading Machinery; C, Gear-cutting Machine with Provision for storing Oil in Base

those from hacksaws or cold saws, the greatest care has to be taken to prevent their entering the pump. This is done in two ways: By using strainers, and by fitting divisions or weirs so that two or three have to be passed before the liquid

reaches the pump chamber. An example is shown in Fig. 29, which illustrates the frame of a hacksaw machine built by Messrs. C. Wicksteed & Co., Ltd. of Kettering (England). Soap-water is used as a lubricant; this is first received in the recess *A* in the bed, and is drained at the front end *B*, which is farthest away from the falling swarth or chips as they are carried back by the blade on its return stroke. A sloping trough then conveys the lubricant to the tank *C*, which has two divisions, as shown. Light swarth which floats on top, cannot pass over the first division, and the clear liquid goes underneath to the pump chamber *D*.

If chips are produced in moderate quantities, it is well to have a separate perforated tray resting on the main pan, and empty this as required. One form is shown in Fig. 28. This tray should be deeper when larger quantities of material are handled, and is placed over the main tank, as shown at *A*, Fig. 30. It is drawn out when full, for getting rid of the chips. For threading machines, the usual arrangement is represented at *B*. This view shows the chip box *A*, with strainer and the settling tank *B*, with a division which prevents any sediment that might pass through the strainer from entering pump *C*. The latter is of the plunger type, and there is an air-vessel on the delivery pipe to insure a more constant flow of lubricant. In some designs, the interior, where the pump is located, forms an oil reservoir of larger capacity than the tank *B*.

Oil is contained only in the foot or base of some machines, corresponding in this respect to automatic screw machines, and the interior of the frame or the bed is used only to receive the chips. The sectional view *C* illustrates a large Brown & Sharpe automatic gear-cutting machine having this arrangement. The base stores the oil (from 25 to 30 gallons) and the chips fall from the cutter-slide to the position indicated, accumulating at the front eventually, and being removed through the opening for treatment in the oil separator.

* * *

ABOLISHING THE "CAN"

BY J. CROW TAYLOR*

It will be a surprise to some to hear that Germany, the country famous for beer and temperate drinking, is now showing a tendency, and a pretty general one at that, to discourage the use of beer by factory employes during working hours. There is what would be called in this country a pretty general disposition among German factory owners to abolish the "can."

As an example of how some handle this matter in Germany a consular report cites the methods used at the works of Ludwig Loewe & Co. of Berlin, where 3000 men are employed. Here they prohibit the beer can during working hours and offer in its place a drink of tea. The company has the tea prepared, puts it into pint bottles and sells it to the men for approximately three-quarter cent per bottle. Arrangements are made so that the tea may be had at any time any of the men desire it. Special trucks are used for distribution and boys wheel the tea about through the works, where bottles can be bought at any time by employes by a system of coupon tickets.

This tendency at present in Germany is in keeping with the attitude of factory owners in the United States. For a good many years now there has been a pretty general disposition to eliminate the use of beer during working hours. Many American mills and factories have long since put the ban on the beer can. Meantime Germany and the German element in this country has clung to it and pled the privilege of temperate drinking in extenuation. Temperate drinking is undoubtedly a great improvement on drunkenness, but it seems we are arriving at an age now which is not merely to be temperate but is to be prohibition so far as strong drink and even the milder drink of beer is concerned during working hours. It may be necessary to substitute tea and coffee in some instances, but as a general proposition it will likely be found eventually that water is a mighty good thing to drink during working hours, and that it will make for the good of the men as well as the employers and reduce accidents as well as increase efficiency.

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A RECORD OF PRESSED FITS*

BY C. F. MACGILL†

Articles on forced or pressed fits have been published in various technical journals of the country during the past ten or twelve years (one by Stanley H. Moore appearing in the transactions of the Society), but in only one of the papers noticed is there any reference to the diameter and length of the hub into which the shaft is forced or the material of which the hub is made—three very important elements in a forced fit. The great difference in allowances recommended, and in the pressures shown in the articles referred to, led me to have an exact record kept of each forced fit, from which were later calculated the tension stress, radial pressure and the coefficient of friction. The accompanying tables are the result.

In my experience, covering about twenty years in charge of shops where forced fits were made, I found that it was not necessary to increase the allowance with the diameter of the shaft, as the increased surface area of the fit added sufficient friction to bring the pressure up to the required tonnage, and that an allowance of from 0.002 inch to 0.004 inch on steel shafts pressed into steel hubs, and an allowance of from 0.003 inch to 0.005 inch on steel shafts pressed into cast-iron hubs of ordinary hardness, gave good results. I have yet to learn of one of these shafts coming loose.

There is no doubt in my mind that allowances greater than 0.006 inch on steel shafts pressed into cast-iron hubs, not only do not serve any useful purpose, but tend to set up strains that are injurious to the casting. One large plant with which I am familiar, issues an allowance table for pressed fits, the allowance gradually increasing with the shaft diameter. This is not followed in their shaft department, but instead a flat allowance of 0.003 inch is used without regard to the diameter of the shaft.

The allowances given by Mr. Moore, in his paper already referred to, are very much too great, while those given by Mr. Riddell in his discussion of the paper, are too low for sizes under 12 inches. According to Mr. Moore's formula $A = (2D + 0.5) \div 1000$. The allowance for an 8-inch shaft would be $(8 \times 2 + 0.5) \div 1000 = 0.0165$ inch, and on a 12-inch shaft $A = 0.0245$ inch. By referring to the accompanying tables of actual fits, it will be seen that an allowance of 0.002 inch on 8-inch shafts pressed into steel hubs, showed pressures of from 60 to 110 tons, and an allowance of 0.004 inch on a 12-inch shaft pressed into a cast-iron hub, showed 130 tons; hence it does not seem that greater allowances are either necessary or advisable.

The records in these tables cover 204 fits of diameters varying in size from 3.5 inches to 20 inches; sufficient in range and number to demonstrate the correctness and value of the practice followed. All of these measurements and gage readings were taken by the same inspector, and as he was a thoroughly reliable man, I am satisfied that they are correct. The records are all of fits made on electric generators and motors. The tables give the diameter of the shaft; the diameter of the bore; the length of the seat; the diameter of the hub; the material of which the hub is made; the allowance (the difference between the diameter of the shaft and the diameter of the bore of the hub into which the shaft is pressed); the pressure in tons required to force the shaft in; the maximum tension stress in the bore, in pounds per square inch; the radial pressure on the surface of the shaft, in pounds per square inch; and the coefficient of friction. The figures are given as a record of actual experience on sizes between the diameters shown. They are not claimed to represent correct practice beyond these dimensions.

The values in the last three columns were figured from formulas developed by Prof. A. Morley and published in *Engineering*, August 11, 1911. In these formulas

R_1 = outer radius of hub;

R_2 = inner radius of hub = radius of shaft after fitting;

$A = R_1 - R_2$ = thickness of hub wall;

$D = 2R_2$ = diameter of shaft;

p_2 = radial compressive stress in pounds per square inch at radius R_2;

* Paper presented before the American Society of Mechanical Engineers, December, 1913.

† Superintendent, Busch-Sulzer Bros., Diesel Engine Co., Second and Utah Sts., St. Louis, Mo.

RECORD OF PRESSED FITS

No. of Record	Diameter of Shaft, Inches	Diameter of Bore, Inches	Length of Seat, Inches	Diameter of Hub, Inches	Material in Hub	Allowance, Inches	Pressure, Tons	Maximum Tension Stress of Bore, Pounds per Square Inch	Radial Pressure on Surface of Shaft, Pounds per Square Inch	Coefficient of Friction
1	3.504	3.500	6	5	Steel	0.004	30	25520	8680	0.105
2	3.504	3.500	6	5	Steel	0.004	45	25520	8680	0.157
3	3.504	3.500	6	5	Steel	0.004	45	25520	8680	0.157
4	3.503	3.500	6	5	Steel	0.003	50	19185	6525	0.233
5	3.504	3.500	6	4½	Steel	0.004	30	27360	6840	0.133
6	4.004	4.000	6	6¼	Steel	0.004	35	21125	8875	0.104
7	4.004	4.000	6	6¼	Steel	0.004	35	21125	8875	0.104
8	4.004	4.000	6	6¼	Steel	0.004	40	21125	8875	0.120
9	4.004	4.000	6	6¼	Steel	0.004	35	21125	8875	0.104
10	4.004	4.000	6	6¼	Steel	0.004	40	21125	8875	0.120
11	4.003	4.000	8	5½	Steel	0.003	30	17175	5325	0.112
12	4.004	4.000	6	6¼	Steel	0.004	35	21125	8875	0.104
13	4.004	4.000	6	6¼	Steel	0.004	35	21125	8875	0.104
14	4.004	4.000	6	6¼	Steel	0.004	45	21125	8875	0.134
15	4.004	4.000	6	6¼	Steel	0.004	35	21125	8875	0.104
16	4.004	4.000	6	6¼	Steel	0.004	33	21125	8875	0.0985
17	4.004	4.000	6	6¼	Steel	0.004	35	21125	8875	0.104
18	4.004	4.000	8	5½	Steel	0.004	40	22900	7100	0.112
19	4.004	4.000	6	7¼	Steel	0.004	50	19545	10456	0.127
20	4.004	4.000	6	6¼	Steel	0.004	45	21125	8875	0.103
21	4.004	4.000	6	6¼	Steel	0.004	50	21125	8875	0.149
22	4.004	4.000	6	6¼	Steel	0.004	50	21125	8875	0.149
23	4.004	4.000	6	6¼	Steel	0.004	45	21125	8875	0.103
24	4.004	4.000	6	6¼	Steel	0.004	45	21125	8875	0.103
25	4.054	4.051	6	6¼	Steel	0.003	40	15915	6286	0.153
26	4.054	4.051	6	6¼	Steel	0.003	40	15915	6286	0.153
27	4.505	4.500	8	6½	Steel	0.005	60	24665	8665	0.122
28	4.505	4.500	8	6½	Steel	0.005	50	24665	8665	0.102
29	4.5035	4.500	8	6½	Steel	0.0035	45	17285	6050	0.131
30	4.505	4.503	6½	5¾	Cast Iron	0.002	20	5750	1455	0.3
31	4.503	4.500	6	10	Cast Iron	0.003	30	7070	4690	0.151
32	4.503	4.500	6	10	Cast Iron	0.003	30	7070	4690	0.151
33	4.503	4.500	8	6½	Steel	0.003	40	14815	5185	0.136
34	4.503	4.500	8	6½	Steel	0.003	40	14815	5185	0.136
35	4.880	4.875	7	7½	Steel	0.005	48	21885	8865	0.101
36	4.880	4.875	6	7¼	Steel	0.005	45	22365	8385	0.117
37	4.880	4.875	6	7¼	Steel	0.005	45	22365	8385	0.117
38	4.880	4.875	7	7¼	Steel	0.005	60	22365	8385	0.143
39	4.880	4.875	7	7¼	Steel	0.005	45	22365	8385	0.107
40	4.880	4.874	6	7¼	Steel	0.006	67	26835	10064	0.145
41	4.880	4.875	7	8	Steel	0.005	40	21060	9690	0.077
42	4.880	4.875	6	7¼	Steel	0.005	50	22365	8385	0.130
43	4.880	4.875	6	7¼	Steel	0.005	50	22365	8385	0.130
44	4.880	4.876	7	7¼	Steel	0.004	40	17890	6710	0.111
45	4.880	4.875	6	7¼	Steel	0.005	50	22365	8385	0.130
46	4.880	4.875	7	8	Steel	0.005	55	21060	9690	0.106
47	4.880	4.875	6	7¼	Steel	0.005	45	22365	8385	0.117
48	4.880	4.875	6	7¼	Steel	0.005	45	22365	8385	0.117
49	4.880	4.875	6	7½	Steel	0.005	45	21885	8865	0.113
50	4.880	4.875	6	7½	Steel	0.005	45	21885	8865	0.113
51	4.880	4.875	6	7½	Steel	0.005	45	21885	8865	0.113

No. of Record	Diameter of Shaft, Inches	Diameter of Bore, Inches	Length of Seat, Inches	Diameter of Hub, Inches	Material in Hub	Allowance, Inches	Pressure, Tons	Maximum Tension Stress of Bore, Pounds per Square Inch	Radial Pressure on Surface of Shaft, Pounds per Square Inch	Coefficient of Friction
52	4.880	4.875	6	7½	Steel	0.005	45	21885	8865	0.113
53	4.880	4.875	7	8	Steel	0.005	55	21060	9690	0.106
54	4.880	4.875	6	7¼	Steel	0.005	40	22365	8385	0.104
55	4.880	4.875	6	7¼	Steel	0.005	50	22365	8385	0.130
56	4.880	4.875	7	8	Steel	0.005	50	21060	9690	0.096
57	5.003	5.000	7¾	10	Cast Iron	0.003	25	6545	3930	0.105
58	5.003	5.000	8	10	Cast Iron	0.003	20	6545	3930	0.081
59	5.002	5.000	5½	7¾	Steel	0.002	50	8500	3500	0.330
60	5.440	5.437	9	13 3/16	Cast Iron	0.003	25	5730	4055	0.0806
61	5.440	5.437	9	13 3/16	Cast Iron	0.003	25	5730	4055	0.0806
62	5.502	5.500	8	13	Cast Iron	0.002	22	3800	2650	0.120
63	5.502	5.500	8½	13	Cast Iron	0.002	25	3800	2650	0.128
64	5.630	5.625	7	13	Cast Iron	0.005	30	9340	6390	0.076
65	5.630	5.625	7½	8¼	Steel	0.005	40	19550	7115	0.085
66	5.629	5.625	8¼	8¼	Steel	0.004	65	15640	5695	0.207
67	5.630	5.625	7½	8½	Steel	0.005	65	19185	7480	0.131
68	5.630	5.625	7	8	Steel	0.005	45	19900	6765	0.1075
69	5.630	5.625	7	8¼	Steel	0.005	65	19550	7115	0.148
70	5.630	5.625	6½	8¼	Steel	0.005	65	19550	7115	0.159
71	5.630	5.625	7	8¼	Steel	0.005	65	19535	7115	0.147
72	5.630	5.625	7	8½	Steel	0.005	55	19185	7480	0.119
73	5.630	5.625	7	9¼	Steel	0.005	48	18260	8405	0.092
74	5.630	5.625	7½	8½	Steel	0.005	50	19185	9480	0.101
75	5.630	5.625	7	8¼	Steel	0.005	55	19535	7115	0.125
76	5.630	5.625	8	8	Steel	0.005	55	20000	6650	0.1185
77	5.7525	5.750	8	12¾	Cast Iron	0.0025	18	4610	3060	0.081
78	5.752	5.750	8	12¾	Cast Iron	0.002	20	3690	2375	0.117
79	6.005	6.000	8	9	Steel	0.005	70	18055	6945	0.134
80	6.002	6.000	8	9	Steel	0.002	55	7220	2780	0.262
81	6.003	6.000	7¾	13¾	Cast Iron	0.003	30	5265	3575	0.115
82	6.005	6.000	8	9	Cast Iron	0.005	30	10485	3225	0.123
83	6.003	6.000	8	14½	Cast Iron	0.003	40	5200	3680	0.144
84	6.0025	6.000	7	13¼	Cast Iron	0.0025	40	4425	2920	0.207
85	6.0025	6.000	8	14½	Cast Iron	0.0025	38	4425	2920	0.172
86	6.130	6.125	7	8¼	Steel	0.005	65	19065	5475	0.176
87	6.253	6.250	9	11½	Steel	0.003	60	19065	5475	0.134
88	6.253	6.250	9	11½	Steel	0.003	65	9320	5080	0.145
89	6.253	6.250	9	11½	Steel	0.003	65	9320	5080	0.145
90	6.2735	6.273	9	11½	Steel	0.0005	15	1550	8401	0.20
91	6.5025	6.500	8	21¾	Cast Iron	0.0025	40	3790	3170	0.155
92	6.503	6.500	8	14¾	Cast Iron	0.003	40	4871	3280	0.149
93	6.502	6.500	8	14¾	Cast Iron	0.002	38	3245	2190	0.213
94	6.503	6.500	6	12	Cast Iron	0.003	40	5160	2835	0.23
95	6.503	6.500	8	13½	Cast Iron	0.003	35	4980	3110	0.134
96	6.502	6.500	8	13	Cast Iron	0.002	25	3355	2115	0.152
97	6.503	6.500	8	11¼	Steel	0.003	90	9220	4610	0.24
98	6.5025	6.500	8	14¾	Cast Iron	0.0025	25	4060	2735	0.112
99	6.503	6.500	8	14¾	Cast Iron	0.003	35	4800	3395	0.126
100	6.502	6.500	12	10	Cast Iron	0.002	50	3680	1495	0.275
101	6.610	6.605	11	14	Steel	0.003	60	8000	5620	0.094
102	6.939	6.937	7¾	13	Cast Iron	0.002	15	3210	1785	0.1

Machinery

RECORD OF PRESSED FITS

No. of Record	Diameter of Shaft, Inches	Diameter of Bore, Inches	Length of Seat, Inches	Diameter of Hub, Inches	Material in Hub	Allowance, Inches	Pressure, Tons	Maximum Tension Stress of Bore, Pounds per Square Inch	Radial Pressure on Surface of Shaft, Pounds per Square Inch	Coefficient of Friction
103	6.939	6.937	8	11	Cast Iron	0.002	17	3410	1465	0.133
104	7.002	7.000	10	12	Steel	0.002	75	5730	2820	0.242
105	7.002	7.000	10	12	Steel	0.002	80	5730	2820	0.268
106	7.003	7.000	10	12½	Steel	0.003	90	8325	4515	0.181
107	7.002	7.000	9	17	Cast Iron	0.002	50	2965	2110	0.24
108	7.003	7.000	10	13	Steel	0.003	85	8285	4615	0.168
109	7.003	7.000	10	13	Steel	0.003	80	8285	4615	0.158
110	7.003	7.000	9	16¾	Cast Iron	0.003	40	4465	3135	0.129
111	7.002	7.000	10	12	Steel	0.002	95	5730	2820	0.307
112	7.003	7.000	8	12¾	Cast Iron	0.003	35	4815	2600	0.153
113	7.003	7.000	10	13	Steel	0.003	50	8285	4615	0.0985
114	7.0035	7.000	8	14¾	Cast Iron	0.0035	45	5375	3400	0.12
115	7.003	7.000	9	17	Cast Iron	0.003	50	4450	3160	0.18
116	7.003	7.000	8	12	Steel	0.003	100	8605	4235	0.269
117	7.034	7.031	8	10½	Steel	0.003	75	9260	3520	0.262
118	7.034	7.031	8	10½	Steel	0.003	35	9260	3520	0.113
119	7.1895	7.187	7	13	Cast Iron	0.0025	25	3915	2085	0.152
120	7.2525	7.2495	9	16¾	Cast Iron	0.003	35	4350	2475	0.115
121	7.437	7.435	7½	11	Cast Iron	0.002	25	3275	1220	0.234
122	7.4395	7.437	8	13	Cast Iron	0.0025	25	3810	1970	0.136
123	7.502	7.499	8	12¾	Cast Iron	0.003	55	4605	2230	0.238
124	7.5025	7.500	8	13	Cast Iron	0.0025	35	3810	1905	0.194
125	7.5027	7.500	8	14½	Cast Iron	0.0027	20	3970	2290	0.0925
126	7.5029	7.501	8	25½	Cast Iron	0.0019	15	2460	2145	0.074
127	7.534	7.531	10	12	Steel	0.003	50	8320	3620	0.117
128	8.002	8.000	9½	13¾	Steel	0.002	60	5015	2485	0.202
129	8.002	8.000	9½	13¾	Steel	0.002	60	5015	2485	0.202
130	8.002	8.000	9½	13¾	Steel	0.002	60	5015	2485	0.202
131	8.002	8.000	16	14	Steel	0.002	110	4975	2525	0.217
132	8.002	8.000	9½	13¾	Steel	0.002	80	5015	2485	0.27
133	8.002	8.000	9½	13¾	Steel	0.002	85	5015	2485	0.286
134	8.002	8.000	9½	13¾	Steel	0.002	75	5015	2485	0.253
135	8.002	8.000	9½	13¾	Steel	0.002	80	5015	2485	0.27
136	8.002	8.000	9	13½	Steel	0.002	80	5065	2435	0.318
137	8.003	8.000	9	17	Cast Iron	0.003	50	4025	2565	0.173
138	8.4395	8.4375	7	11	Cast Iron	0.002	25	3060	795	0.34
139	8.4395	8.437	8	11	Cast Iron	0.0025	18	3820	833	0.205
140	8.440	8.4375	8	11	Cast Iron	0.0025	15	3820	833	0.17
141	8.503	8.500	8	14¾	Cast Iron	0.003	35	4035	2015	0.162
142	8.503	8.500	8	14½	Cast Iron	0.003	45	4055	1980	0.212
143	8.503	8.500	9	15	Cast Iron	0.003	40	3815	2370	0.141
144	8.503	8.500	8	14¾	Cast Iron	0.003	45	4435	2020	0.208
145	8.5025	8.500	6½	15	Cast Iron	0.0025	30	3000	2255	0.154
146	8.505	8.5015	8	15	Cast Iron	0.0045	45	6005	3085	0.136
147	8.507	8.504	9	11	Cast Iron	0.003	40	4565	1145	0.292
148	8.564	8.562	14	13½	Cast Iron	0.002	30	2765	848	0.1875
149	8.939	8.937	8	13	Cast Iron	0.002	18	2860	762	0.211
150	8.939	8.937	8	13	Cast Iron	0.002	20	2860	762	0.234
151	8.939	8.937	8	13	Cast Iron	0.002	22	2860	762	0.257
152	9.002	8.999	12	20½	Cast Iron	0.003	65	3515	2375	0.161
153	9.002	8.999	12	20½	Cast Iron	0.003	65	3515	2375	0.161

No. of Record	Diameter of Shaft, Inches	Diameter of Bore, Inches	Length of Seat, Inches	Diameter of Hub, Inches	Material in Hub	Allowance, Inches	Pressure, Tons	Maximum Tension Stress of Bore, Pounds per Square Inch	Radial Pressure on Surface of Shaft, Pounds per Square Inch	Coefficient of Friction
154	9.0025	8.999	12	20½	Cast Iron	0.0035	75	4100	2375	0.159
155	9.0025	8.999	12	20½	Cast Iron	0.0035	75	4100	2375	0.159
156	9.0015	8.9995	9	16¾	Cast Iron	0.002	22	2480	1870	0.126
157	9.002	9.000	10	14	Steel	0.002	80	4710	1955	0.29
158	9.002	9.000	10	14	Steel	0.002	75	4710	1955	0.272
159	9.003	9.000	12	20¾	Cast Iron	0.003	70	3500	2395	0.171
160	9.003	9.000	12	20¾	Cast Iron	0.003	70	3500	2395	0.171
161	9.003	9.000	12	21	Cast Iron	0.003	70	3495	2410	0.171
162	9.003	9.000	12	20¾	Cast Iron	0.003	70	3500	2395	0.171
163	9.002	9.000	13	20½	Cast Iron	0.002	75	2345	1585	0.257
164	9.003	9.000	12	20¾	Cast Iron	0.003	90	3500	2395	0.22
165	9.003	9.000	12	14¾	Cast Iron	0.003	85	3890	1775	0.298
166	9.003	9.000	10	18⅜	Steel	0.003	100	6200	3795	0.187
167	9.003	9.000	10	18⅜	Steel	0.003	80	6200	3795	0.149
168	9.003	9.000	9	17	Cast Iron	0.003	45	3700	2080	0.17
169	9.003	9.000	9	17	Cast Iron	0.003	50	3700	2080	0.189
170	9.939	9.937	7½	13	Cast Iron	0.002	25	2745	720	0.295
171	9.9998	9.996	9	16¾	Cast Iron	0.0038	60	4400	2080	0.204
172	10.003	10.000	9	16¾	Cast Iron	0.003	40	3495	1640	0.172
173	10.004	10.000	12	21	Cast Iron	0.004	90	4205	2715	0.176
174	10.0035	10.000	14	21	Cast Iron	0.0035	80	3765	2375	0.153
175	10.002	10.000	12	18	Steel	0.002	55	3925	2475	0.128
176	10.502	10.500	8	13	Cast Iron	0.002	16	2505	550	0.22
177	11.002	11.000	12⅝	18	Steel	0.002	70	3750	1705	0.189
178	11.002	11.000	12⅝	18	Steel	0.002	80	2750	1705	0.216
179	11.005	10.9997	14	20¾	Cast Iron	0.053	38	5350	3005	0.0525
180	11.002	11.000	12¾	18	Steel	0.002	85	3750	1705	0.24
181	11.002	11.000	13½	18	Steel	0.002	90	3750	1705	0.227
182	11.002	11.000	13	18	Steel	0.002	90	3750	1705	0.235
183	11.002	11.000	13	18	Steel	0.002	70	2750	1705	0.183
184	11.002	11.000	12¾	18	Steel	0.002	90	3750	1705	0.24
185	11.002	11.000	13	18	Steel	0.002	100	3750	1705	0.261
186	11.0025	11.000	10	17½	Cast Iron	0.0025	50	2680	1160	0.25
187	11.0035	11.000	10	17½	Cast Iron	0.0035	60	2755	1625	0.214
188	11.064	11.062	12	18¾	Cast Iron	0.002	48	2100	975	0.236
189	12.004	12.000	12	20¾	Cast Iron	0.004	130	3815	1895	0.302
190	12.003	12.000	13	20½	Cast Iron	0.003	70	2875	1405	0.204
191	12.004	12.000	13	21	Cast Iron	0.004	78	3795	1930	0.165
192	13.0045	13.002	13	21½	Cast Iron	0.0025	100	2235	1035	0.362
193	13.003	13.000	14	22	Cast Iron	0.003	85	2660	1265	0.235
194	13.0045	13.000	12	22	Cast Iron	0.0045	90	4000	1905	0.193
195	13.0045	13.000	12	22	Cast Iron	0.0045	100	4000	1905	0.213
196	13.003	13.000	12	25½	Cast Iron	0.003	70	2530	1470	0.195
197	13.004	13.000	13	26	Cast Iron	0.004	100	3355	2015	0.187
198	13.0035	13.000	13	22	Cast Iron	0.0035	110	3105	1490	0.252
199	13.003	13.000	12¾	21	Steel	0.003	125	4790	2130	0.225
200	14.033	14.031	14	21	Steel	0.003	150	4785	1845	0.264
201	14.033	14.031	14	21	Steel	0.002	100	3075	1185	0.274
202	14.5035	14.500	13	25½	Cast Iron	0.0035	100	2720	1430	0.235
203	16.004	16.000	14	25½	Cast Iron	0.004	120	2865	1415	0.241
204	20.002	20.000	20	28⅞	Steel	0.002	160	2220	780	0.327

Machinery

f_t = hoop tension per square inch at radius R_2;

J = excess in original diameter of shaft over that of bore of hub = allowance;

E = Young's modulus for shaft material, assumed, 30,000,000
E_1 = Young's modulus for hub material, assumed, 15,000,000 } thus $E = 2E_1$;

$\frac{1}{m}$ = Poisson's ratio for shaft material
$\frac{1}{m_1}$ = Poisson's ratio for hub material } assumed $m = m_1 = 4$

Total tension stress at bore of hub

$$f_t = \frac{\frac{J}{D} \times E}{\left(\frac{m-1}{m} + \frac{1}{m_1} \times \frac{E}{E_1}\right)\frac{R_1^2 - R_2^2}{R_1^2 + R_2^2} + \frac{E}{E_1}}$$

Radial pressure on shaft

$$p_2 = \frac{\frac{J}{D} - \frac{f_t}{E_1}}{\frac{m-1}{mE} + \frac{1}{m_1 E_1}}$$

Coefficient of friction

$$\mu = \frac{P}{P_2}$$

where

P_2 = total normal pressure in tons;

P = pressure in tons required to force shaft into hub.

Cast-iron hub on steel shaft $D = 6.0025$ inches, $J = 0.0025$ inch, length of hub $l = 7$ inches, thickness of hub $t = 3\frac{5}{8}$ inches. Assuming $m = m_1 = 4$ and $E = 2E_1 = 30{,}000{,}000$ then

$$\text{Max. tension stress } f_t = \frac{\frac{0.0025}{6} \times 30{,}000{,}000}{(\frac{3}{4} + \frac{1}{4} \times 2)\frac{44-9}{44+9} + 2} = 4425$$

pounds per square inch.

$$\text{Radial pressure } p_2 = \frac{\frac{0.0025}{6} - \frac{4425}{15{,}000{,}000}}{\frac{3}{4 \times 30{,}000{,}000} + \frac{1}{4 \times 15{,}000{,}000}} =$$

2920 pounds per square inch

$$\text{Coefficient of friction} = \frac{40}{\frac{\pi \times 6 \times 7 \times 2920}{2000}} = 0.207$$

* * *

PFAUTER PATENTS ON GEAR HOBBING MACHINES IN GERMANY

The German Pfauter patent No. 112,082 class 49a on spiral gear hobbing machine expired September 1, 1912. The patent for this invention by Mr. Pfauter was taken out by the Chemnitzer Strickmaschinenfabrik of Chemnitz in 1897 and expired at the end of fifteen years. As the patents have expired, anyone can build hobbing machines in Germany on the Pfauter system. When Pfauter applied for patents on his hobbing machine he made application for both spur and spiral gear machines but after making a thorough examination, the patent office discovered that the hobbing method as applied to cutting spiral gears only could be protected, inasmuch as the hobbing principle of cutting spur gears had been known for thirty or forty years. Up to September 1, 1912, only two makers were permitted to manufacture hobbing machines for cutting spiral gears, these being Mr. Pfauter, whose entire product was taken over by the Schuchardt & Schütte Co., and Biernatzki & Co., who had acquired the patent rights from the Chemnitzer Strickmaschinenfabrik.

LAMINATED SPUR GEARS

A new method of making spur gears to secure accuracy and silent operation which is being developed commercially by Laminated Gears, Ltd., Sedgley Road, Owlerton, Sheffield, England, was described in *Page's Engineering Weekly*. This new gear, which is the invention of Arthur E. Terry, consists of a number of thin disks in which teeth have been formed by dies. These disks, which may be of brass, mild steel, high-tensile steel, etc., are placed side by side and clamped together by rivets. In assembling the gear, successive disks are displaced a distance equal to one-half the circular pitch, so that the teeth are staggered as shown in Fig 1. These disks

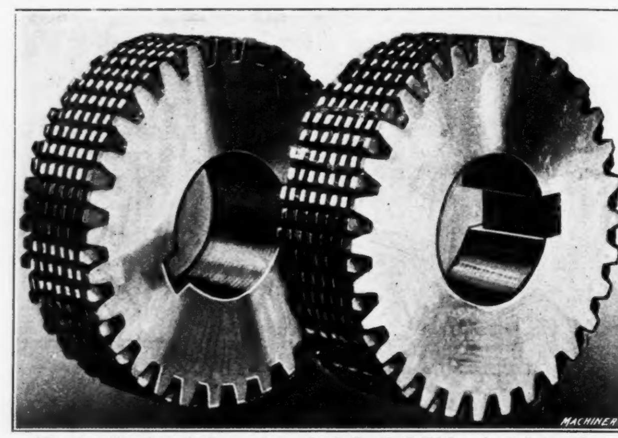

Fig. 1. Laminated Gears formed of Toothed Disks riveted together

are located on the tooth notching machine, by the bore and keyway, so that each disk has exactly the same pitch diameter. Between the plates of an assembled gear are metal washers varying from 0.001 to 0.012 inch thick, in accordance with requirements. These washers provide a slight clearance for the meshing teeth. The laminated gears are said to produce very little noise in operation, owing to the fact that the impact of the meshing teeth is halved, thus lessening the noise produced; moreover, as the gear is formed by a number of laminations, it cannot vibrate as a whole, and if one of these gears is suspended and struck by a hammer,

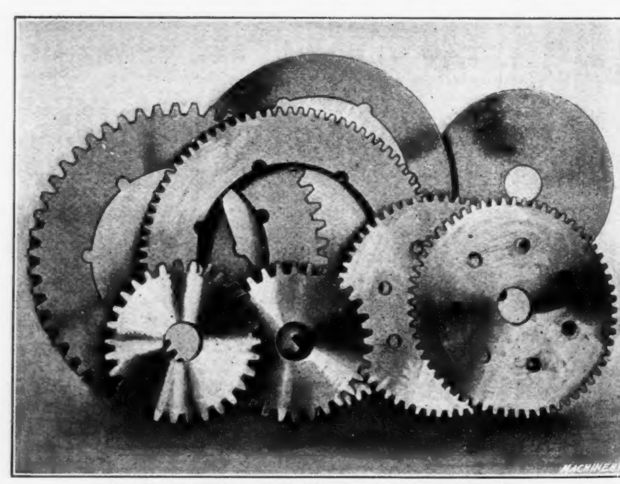

Fig. 2. Stampings and Blanks for Laminated Gears

the sound produced is about the same as would be obtained by striking a disk of lead; hence, the vibrations which produce a ringing sound in the case of a solid gear are entirely eliminated, owing to the laminated construction. It is claimed that when laminated gears are hardened there is no danger of distortion, because in the hardening processes the plates can be packed on a mandrel so as to form a long pinion with the teeth in line. When the plates thus assembled are casehardened, they will only be hard on the working faces of the teeth, and, consequently, the distortion of the plates will be slight; furthermore, when they are assembled, what little distortion there may be in each individual plate will be neutralized.

* * *

No one was ever lost on a straight road.

COMPARATIVE TESTS OF THREE TYPES OF LINESHAFT BEARINGS*

RELATIVE POWER CONSUMPTION AND COEFFICIENTS OF FRICTION FOR BALL, ROLLER AND BABBITT BEARINGS

These tests were made in order to ascertain definitely the relative and absolute amounts of power required to drive a specially constructed lineshaft carrying given loads at certain known speeds of revolution, when supported successively by three different types of shaft bearings, and to determine coefficients of friction for each type. The three types tested were ring-oiled babbitt bearings, roller bearings and ball bearings. Twenty bearings of each type were used in order that representative results might be obtained.

The design of the apparatus was made with the assistance of the manufacturers of the bearings to whom preliminary drawings were submitted, and during the four years of the tests representatives of these firms have visited the laboratory for the purpose of giving whatever advice and assistance was possible. The preliminary work, covering the first two years, showed the necessity of considering the temperature of the oil film in the babbitt and roller bearings, and it was only after careful study of the temperature question with regard to all three types that satisfactory results were finally obtained.

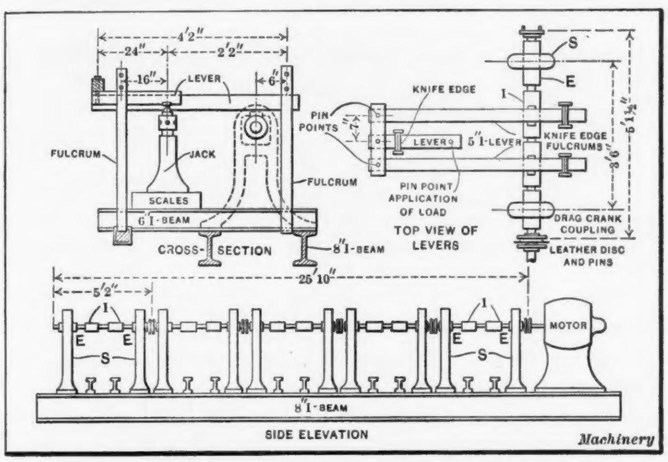

Fig. 1. Diagram of Apparatus for testing Lineshaft Bearings

Description of Testing Apparatus

The apparatus consists of 25 feet 10 inches of lineshafting in five equal sections, mounted in hangers *S* (see Fig. 1) which are inverted and used as floor stands. The hangers are bolted to two 8-inch I-beams which are leveled upon the floor. The shafts are of cold-rolled steel, 2 7/16 inches in diameter. Each section is 5 feet 2 inches long; the adjacent sections are coupled together by means of a flexible leather disk or two straps connecting the two flange couplings. The flexible couplings prevent transmitting any part of the load applied on one shaft, to either adjoining section, and also prevent binding between shafts and bearings due to possible lack of alignment.

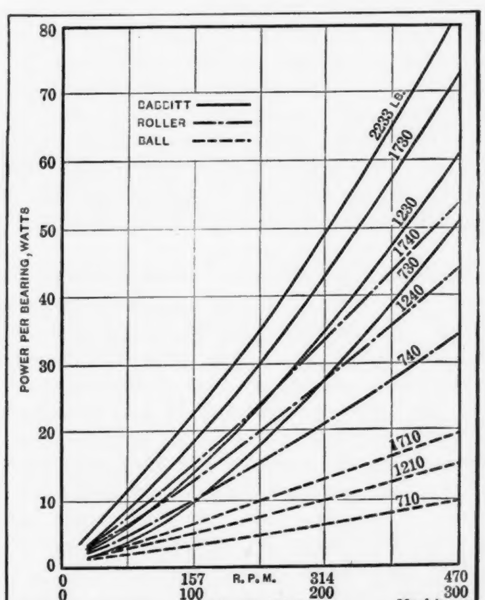

Fig. 2. Comparison of Power consumed by Friction in Babbitt, Roller and Ball Bearings at Various Speeds, with Loads per Bearing as indicated—Temperature of Bearing 100 Degrees F.

A direct-current Fort Wayne motor is directly connected to one end of the shafting by means of a flexible coupling. The motor is of the interpole type with the interpoles removed, making it a shunt motor. Its rating with the interpoles is 7½ horsepower, 28 amperes, 400/1600 revolution per minute, four pole, 230 volts. The power required to run the motor alone at all speeds, without load, was accurately ascertained, as well as the power required to run the motor and shafts together, at all loads and speeds. The relative amounts of power required to overcome the friction of the various types of bearings were therefore accurately determined.

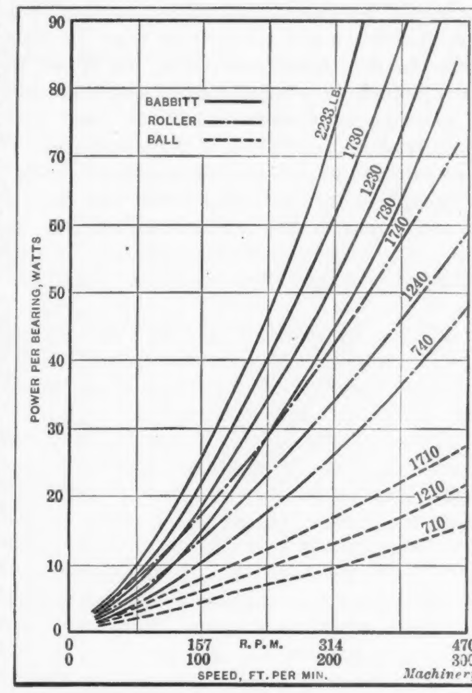

Fig. 3. Comparison of Power consumed by Friction in Babbitt, Roller and Ball Bearings—Temperature of Bearing 77 Degrees F.

The load was applied through levers having hardened knife edges and pin points as fulcrums. Across the top of the 8-inch I-beams and at right angles to them, are bolted short 6-inch I-beams to which the fulcrums are attached. Standard 1000-pound scales are set upon the 6-inch I-beams. A double system of leverage is used in order to get sufficient load upon the bearings with as short a length of lever as possible.

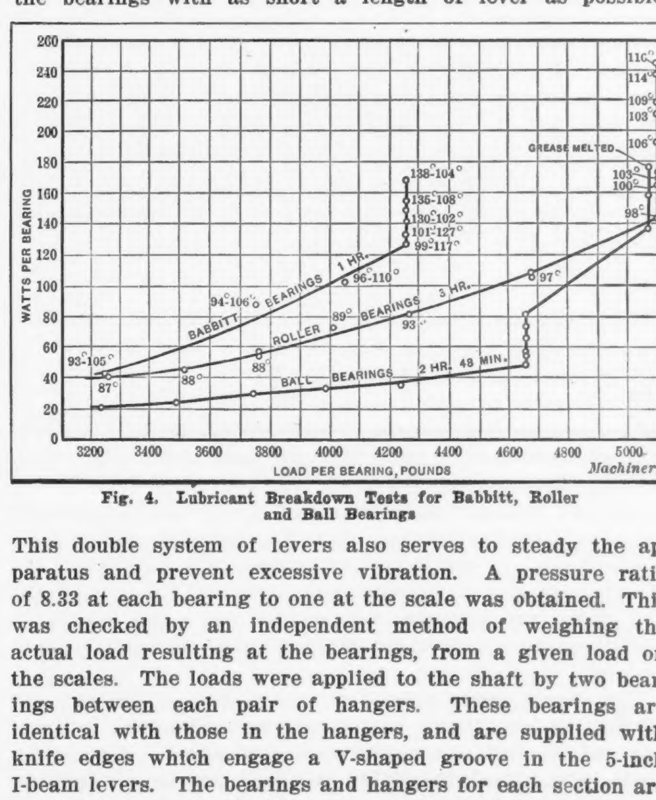

Fig. 4. Lubricant Breakdown Tests for Babbitt, Roller and Ball Bearings

This double system of levers also serves to steady the apparatus and prevent excessive vibration. A pressure ratio of 8.33 at each bearing to one at the scale was obtained. This was checked by an independent method of weighing the actual load resulting at the bearings, from a given load on the scales. The loads were applied to the shaft by two bearings between each pair of hangers. These bearings are identical with those in the hangers, and are supplied with knife edges which engage a V-shaped groove in the 5-inch I-beam levers. The bearings and hangers for each section are symmetrically placed with respect to the middle of the sec-

* Abstract of paper by Carl C. Thomas, E. R. Maurer and L. E. A. Kelso, presented before the American Society of Mechanical Engineers, December, 1913.

tion; therefore, equal loads on the intermediate bearings *I* produce equal pressures on the end bearings *E*. The reason for using twenty bearings was that the amount of power necessary for a single bearing was so small as to be difficult of measurement; moreover any single bearing might not truly represent results that would be obtained from that type of bearing in general.

The Bearings Tested

The three kinds of bearings tested were: the Hess-Bright ball bearing manufactured by the Hess-Bright Mfg. Co.; the ring-oiled bearing manufactured by the Dodge Mfg. Co., lined with babbitt metal made from their formula; and the Hyatt roller bearing manufactured by the Hyatt Roller Bearing Co. All bearings were for the same size shaft and the same pieces of shafting were used for all the tests, except that two sections bent during the tests were replaced. The babbitt bearings are 9 21/32 inches long and hence their projected area is 22.36 square inches.. These bearings were oiled by the well-known ring-oiler device, there being two rings in each bearing. Each roller bearing contains six right-hand and six left-hand rollers, 0.780 inch in diameter; six are 9 9/16 inches long and six are 9 3/16 inches long. The bearings are of the type in which a cage is used for holding one-half the rollers. Each ball bearing contains a single set of balls 9/16 inch in diameter. The diameter of the inner race across the ball groove is 3.4729 inches.

Mercury thermometers (two in each babbitt and roller bearing, and one in each ball bearing) were used for measuring the temperature of the oil or bearing. In order to avoid the endwise thrust of the shaft, when supported by the roller bearings, it was necessary to interpose two ball thrust collars. Before this was done, excessive vibration of the motor and of the apparatus resulted from the tendency of the shaft to move endwise. This was particularly troublesome at high loads and speeds.

Procedure when Making Tests

The power was measured by the ammeter voltmeter method. A second ammeter was used as a check on the first; and a watt-meter (arranged for direct and reverse readings) as a further check. The general order of taking data was as follows: Clean the commutator; adjust motor to speed; take all power readings; read all thermometers; adjust speed again and repeat power measurements. This gave the power both before and after the temperature was taken, the mean of which would give the mean power for the mean temperature very closely. In addition, the readings acted as a check on each other.

The manner of making a test or run was essentially as follows: Each night the plant was run from three to twelve hours under the load and speed to be used during the run of the following day, but without observation. The purpose of the preliminary night run was to allow the shaft and bearings to adjust themselves to the conditions of the run. Then on the following day the shaft was run from three to six hours and frequent observations of power and temperature were made during the run. The first few observations were made as often as practicable (about five minutes apart); the others, generally at fifteen-minute intervals, but toward the end of the run when the temperature was rising slowly observations were made at intervals generally of thirty minutes or more.

TABLE I. RELATIVE AMOUNTS OF POWER CONSUMED IN FRICTION

Bearings	100 Feet per Minute		300 Feet per Minute	
	77 Deg. F.	100 Deg. F	77 Deg. F.	100 Deg. F.
Ball	1	1	1	1
Roller	2.2	2.5	2.7	3
Babbitt	3	3.6	4.5	4

Machinery

The speeds used in the tests were between 150 and 450 revolutions per minute, corresponding, respectively, to about 100 and 300 feet per minute peripheral speed. Most of the loads used were between 700 and 1800 pounds per bearing, corresponding, respectively, to about 30 and 80 pounds per square inch for the babbitt bearings. All statements of results therefore are subject to the above limitations as to speed and loads. Two lubricants were used in all the tests: Atlantic red engine oil in the babbitt and roller bearings, and No. 2 Keystone grease in the ball bearings.

Relative Power Consumption

Figs. 2 and 3 show a comparison of the power consumed by friction in the babbitt, roller and ball bearings for bearing temperatures of 100 degrees and 77 degrees F., respectively. Each curve gives the power required per bearing of the kind indicated, to run the shaft under the load and speed given. The power required for the babbitt bearings is higher than for the other bearings, except perhaps at low loads and speed, and the power for roller bearings is higher than for ball bearings. The excess of power for babbitt over rollers, and rollers over balls, increases with increase of speed for all loads. Table I shows the relative amounts of power consumed in friction by the three kinds of bearings at the speeds and temperatures indicated; the relative numbers are based, in each case, on the average power for the three loads: 710, 1210, and 1710 pounds for balls; 740, 1240, and 1740 for rollers; and 730, 1230 and 1730 for babbitt.

TABLE II. COMPARISON OF COEFFICIENTS OF FRICTION

Type of Bearing	Coefficient of Friction					
	Load, 727 Pounds		Load, 1227 Pounds		Load, 1727 Pounds	
	77 Deg	100 Deg.	77 Deg.	100 Deg.	77 Deg.	100 Deg.
Ball	0.0025	0.0019	0.0022	0.0018	0.0020	0.0016
Roller	0.0069	0.0055	0.0055	0.0047	0.0049	0.0042
Babbitt	0.0112	0.0075	0.0082	0.0058	0.0070	0.0051

Machinery

The coefficients of friction for the three types of bearings, when subjected to average loads of 727, 1227 and 1727 pounds, respectively, and temperatures of 77 and 100 degrees F., are given in Table II. The peripheral speed was 150 feet per minute.

Lubricant Breakdown Tests

In order to observe the performance of the bearings under extraordinarily heavy loads, "breakdown tests" were run on each type of bearing with only one section of shafting on which were four bearings. This small number of bearings was used because it was impracticable to keep close watch of a larger number and avoid trouble during the excessively severe conditions. The maximum load was 600 pounds on the scales, or about 5000 pounds per bearing. The results are shown in Fig. 4. A speed of 200 revolutions per minute was chosen because it represents about the average lineshaft speed in practice. These tests began at about 3200 pounds per bearing. Failure occurred at about 4250 pounds per bearing in the case of the babbitt, 4650 pounds in the case of the ball bearings, and about 5100 pounds in the case of the roller bearings.

The quality and amount of lubricant used undoubtedly have an important effect upon the load that will cause a given bearing to fail. The bearings did not in any case fail structurally, as the power was cut off soon after distress was manifested, but the failure was simply that of the lubricant. Breaking down of the lubricant resulted in an immediate increase of the power required to maintain the original speed of rotation of the shaft in the bearings. In each case probably only one of the four bearings used in the breakdown tests showed distress at any one time. In the case of ball bearings, distress was manifested by disintegration of the grease which "melted" and ran out of the bearing. This was accompanied by the immediate increase in power requirement, as shown in Fig. 4. The temperatures given (99 degrees, 117 degrees, etc.) indicate the averages for the four bearings being tested. Similar behavior on the part of the babbitt and the roller bearings indicated that at least one of the four under test was suffering from an approach to "metal-to-metal" contact. The bearings were not injured by these endurance tests, and all were used in subsequent tests at the more usual speeds and pressures.

CENTRALIZED CONTROL SYSTEM FOR PANAMA CANAL LOCKS

ELECTRICAL CONTROL-BOARD WITH INDICATORS TO SHOW POSITIONS OF GATES, VALVES, ETC., AND MECHANICAL INTERLOCKING SYSTEM

In an article on the Panama Canal published in the April, 1913, number of MACHINERY, a general description of the electrical control system for operating the locks was given, and the ingenious mechanical interlocking system to prevent all dangerous combinations in the relative positions of gates, valves, etc., was also referred to. These control and interlocking systems constitute one of the most interesting features of the canal for the mechanical and electrical engineer, and now that they have been installed in the locks, we are able to present a more complete description. In order to clearly understand this control system, one must be familiar with the general arrangement of the locks, which were described in detail in the article referred to, published in the April number.

An electrically operated centralized control system was necessary owing to the size of the locks. For instance, the flight of locks at Gatun has a total length of approximately 6200 feet, and the principal operating machines are distributed over a distance of about 4000 feet, so that any form of mechanical transmission for controlling these machines would be almost impossible. The control-boards are installed in houses located on the middle lock walls at points which afford the best view of the locks. The position of the gates or other apparatus is shown by indicators on the control-board so that the operator does not need to actually see the various parts which he controls. The control-boards are, to some extent, miniatures of the locks themselves, and, with the exception of that machinery which only needs an "open" or "closed" indication, the indicating devices will act in synchronism with the movement of the lock machinery to which they are connected. One of these control-boards is shown in Fig. 1. It is a flat-top bench-board type, 32 inches high and 54 inches wide. The total length of these boards varies for different locks as follows: Gatun, 64 feet; Pedro Miguel, 36 feet; Miraflores, 52 feet. On top of the control-board, the side and center walls of the locks are represented by cast-iron plates and the water in the locks by blue Vermont marble slabs. The control switch handles are mounted above the surface of the board, as well as the various indicating devices.

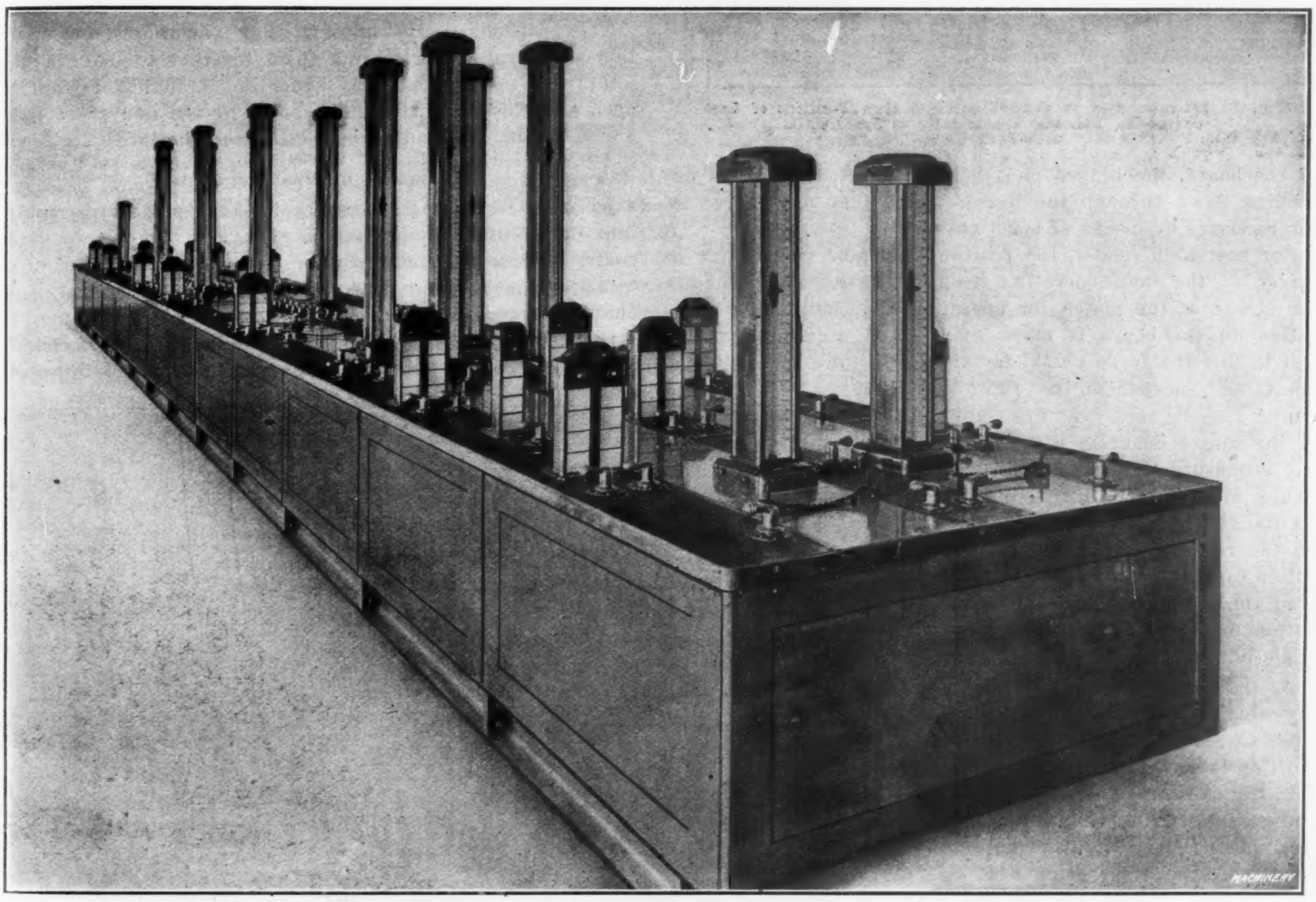

Fig. 1. Lock Control-board for Miraflores Locks of Panama Canal—The Water Levels in Different Chambers and Positions of Gates, Valves and Fender Chains are shown by the Indicators seen on Control-board

Operation of Control-board Indicators

A synchronous indicator for showing the movement of a lock member, has a transmitter located at and operated by the mechanism in the lock wall, and a receiver operating an indicator at the switchboard in the control house. Both transmitter and receiver have a stationary and a rotating part. The movement of the lock machinery and the connected transmitter rotor produces a field in the transmitter stator polarized in the direction of the rotor axis, which induces voltage in the stator coils. This voltage is transmitted by a three-phase connection to the receiver stator coils and duplicates in them, but in the reverse direction, the conditions of polarity and voltage in the transmitter. The rotor of the receiver being energized by the external source in the same direction as that of the transmitter, is reacted upon by the polarized receiver stator until the magnetic axes coincide and the rotors of both transmitter and receiver are in the same relative positions. Any difference in the position of the transmitter and receiver rotors causes a difference of potential between the stator windings, with a consequent flow of current, and resultant torque, which again moves the receiver rotor to the same relative position as that of the transmitter rotor. The receiver rotor follows closely and smoothly the movement of the transmitter rotor, and, consequently, imparts to the control-board indicator a movement identical with the movement of the lock machine, although on a reduced scale. A brief description of the different synchronous indicators follows:

Indicators for Lock Gates, Fender Chains and Valves

In the case of the lock gates, the vertical operating shaft is connected to a shaft which operates the transmitter machine. The latter shaft is threaded and carries a nut on which is mounted a rack. The rack engages a gear on the rotor shaft, and this turns the rotor as the gates operate. The mitering gate indicator (See Fig. 2) comprises a pair of aluminum leaves, shaped to correspond to a plan view of the gates. These leaves travel horizontally just above the top

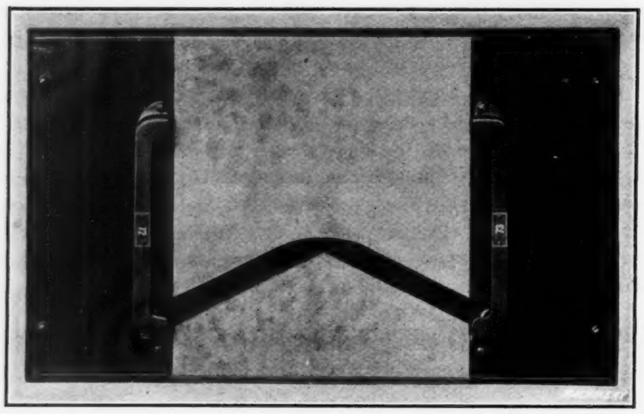

Fig. 2. Indicator used on Control-boards to show Positions of Lock Gates—The Indicator Leaves move in Synchronism with Lock Gates

of the board, the hinged ends being connected to shafts extending down through the board, where they are geared to the receivers by means of bevel gears.

For the chain fender, the position indicator transmitter is driven by the shaft operating the limit switch that controls the stroke of the piston for operating the chain. The indication on the board is given by a small aluminum chain, which, like the large chain, is raised and lowered, each end operating independently. Two of these chains may be seen near the right-hand end of the control-board in Fig. 1. The ends of the miniature chains are fastened to semaphore arms which are connected to segmental gears meshing with the driving gears on the receiver machines. As the receiver rotors turn, the chain is either lifted or lowered, the position of the large chain from the bottom of the lock being indicated by the angle of the semaphore arms.

As the gate valves which control the flow of water into the main feed culverts are in pairs to reduce the size of each valve, their position indicator machines are also in pairs. The transmitter rotor is driven by a shaft and gearing similar to that described for the lock gates. Each indicator is similar to a small elevator, a car being used to indicate the position of the gate valve. Both the front and back of the shaft is fitted with opaque glass marked with black lines for the one-quarter, one-half and three-quarter positions. A small aluminum cage moves up and down in each compartment. A drum for operating the cord which raises and lowers the cage is located underneath the control-board and is operated by the receiver through a suitable train of gears. To make the indications visible from points up and down the control-board, the elevator shaft under each car is always illuminated and the portion above is dark. These indicators are located on the cast-iron plates of the control-board, which, as previously mentioned, represent the side walls of the lock. (See Fig. 1.)

Water Level Indicators

The specifications for the water level indication required an accuracy of 1/20 foot in actual water level. In the transmitters and receivers for the machines described previously, the rotors turn less than 180 degrees with an inherent lag of 1½ per cent between transmitter and receiver rotors in this distance, which, obviously, prevents this arrangement from being employed to give the water level indication. The required accuracy was obtained by two sets of transmitters and receivers. One set is connected to a "fine" index in which the rotors make ten complete revolutions, and the other set is connected to a "coarse" index operating less than 180 degrees. The fine index is a hollow column carrying a pointer. The length of the column is such that when an aluminum ball representing the coarse index (which can be depended upon for coarse indication) is within the limits of the column, the reading of the fine index is correct within the limits specified. The scales are illuminated by lamps at the base and top of the indicator. These indicators, which may be seen in Fig. 1, are the tall column-shaped members mounted on the marble slabs. To operate the water level indicators there are wells 36 inches square in the lock walls, which communicate with the lock by a small opening at the bottom of the well. These wells contain steel box floats, 30 inches square by 9 inches deep. A non-slipping phosphor-bronze belt transmits the movement of the float to a sheave fitted with pins on the transmitter mechanism, the pins registering with holes punched in the belt.

The positions of the miter forcing machines (for locking the closed gates and forcing them together to make a good joint) are not indicated by synchronous indicators, but the open and closed positions are shown by red and green lights and a mechanical indicator on the control-board.

Mechanical Interlocking System

In order to make it necessary for the operator to manipulate the control-switch handles always in the proper order, corresponding to a predetermined sequence of operations of the lock machinery, and to prevent the operator in control of one channel from interfering with the machinery under the jurisdiction of the operator controlling the other channel, the control switches are provided with mechanical interlocks.

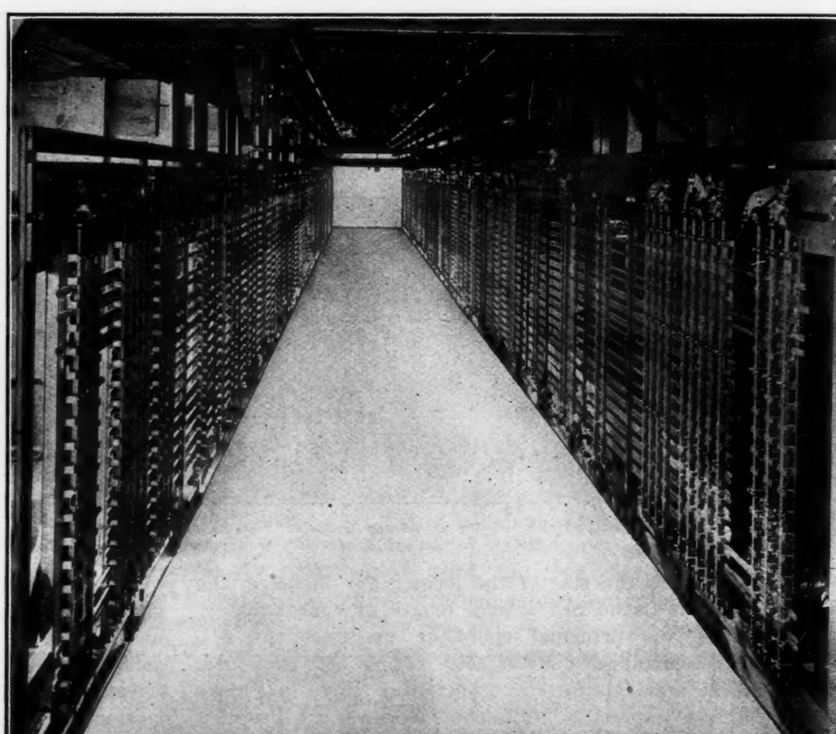

Fig. 3. Mechanical Interlocking Bars located beneath Control-board to prevent Dangerous Combinations in Relative Positions of Gates, Valves, etc.

The interlocks, which are shown in Fig. 3, are in two vertical racks under each edge of the board and some distance below, so that they may be inspected and oiled from a floor which is about seven feet below the floor on which the switchboard operator stands. Vertical shafts operated by connecting-rods from the control switch shafts extend downward past the electrical parts, for the operation of the interlocks. The interlock system is essentially a bell-crank mechanism, connecting the shaft of the control switch through a movable horizontal bar, to a vertical operating shaft which can or can-

not move, according to the relative positions of the interlocking bars and dogs. The interlocking system depends mainly on the action of engaging bevel dogs located on the horizontal and vertical bars, the movement of a horizontal bar tending to lift a vertical bar by bevels on the dogs. A horizontal bar cannot be moved without raising a vertical bar; thus, if at any time a dog on a horizontal bar rests against the upper end of a dog on a vertical bar, no movement of the horizontal bar where the dog engages with the vertical bar can take place, and the control handle connected to that particular horizontal bar is locked.

Interlocks prevent the chain fender from being lowered until adjacent lock gates have been opened, and also prevent the gates from being opened until the chain is in the raised position. In this way it is insured that the chain fender will always be in the up position to protect the gate when the gate is closed. After the lock gates are closed the miter forcing machine which locks the ends of the gates cannot be operated until the gates are closed.

The gate valves for the side wall culverts, next above or below a lock gate, must be closed while the miter forcing machine is open. As the miter forcing machine cannot be closed until the gates are closed, this means that the valves either above or below the gate must remain closed until the gate itself is closed, thus preventing the operator from creating a current of water around the gates while they are open, or are being opened or closed. This interlock is not included on the middle wall valves for the reason that they will be used with the locks on either side and must be free for that purpose.

The gate valves are not only installed in pairs, but each pair is in duplicate. One pair of duplicates is left open as a guard, or reserve pair, and the other is used for operating, so that in case of an obstruction in the culvert or accident to the machinery, the duplicate pair can be used. Either pair of gate valves may be opened first, at the choice of the operator, an interlock becoming effective when the first valve of the second pair of duplicates is opened. The control of these valves is interlocked so that if the valves are opened at one particular point, the valves a lock length upstream or downstream cannot be opened. Thus the operator is limited to equalizing the water between locks and cannot allow water to flow from the upper lock past the middle lock into the lower lock, which operation, if permitted, might flood the lower lock walls and the machinery chambers in them.

The cylindrical valves (which control the flow of water to the lateral feed culverts) are interlocked so that if those on one side are opened the ones on the other side are locked closed, and the opening of one switch on a side will lock the opposite ten. This prevents careless cross filling between locks, which operation might be combined with the regular method and produce flooding. However, there may be times when it is desirable to employ cross filling to economize in the use of water from Lake Gatun, in the cry season. For this reason this interlock is made removable by the use of a Yale lock and key. The key will be placed in the hands of the chief operator. In the use of the middle wall culvert, the cylindrical valves on one side or the other must be opened before the main gate valves can be opened, and the latter must be closed first. This interlock is applied in order to require the operator to control the flow of water by means of the gate valves rather than by the cylindrical valves.

In most cases the locks are divided into two unequal parts by intermediate lock gates. This arrangement makes it necessary to divide the ten cylindrical valves into two groups of seven and three, respectively, for the long and short lengths. A lever is provided for these interlocks and may be set as indicated by a nameplate on the lever to "three," "seven," or "ten," respectively; then the corresponding valves are subject to that interlock, and the others of the group of ten are locked closed if three or seven only are to be used. The failure of the operator to make his selection properly in advance will simply cause him the trouble of going back and doing so, as the remaining valves are locked closed. This arrangement permits handling small vessels without causing waste of water due to operating such vessels in the large chambers. If a short vessel were being passed downstream it would first enter the chamber having three cylindrical valves. The group selective lever would then be placed on the "three" position which would permit the opening of three valves above the intermediate gate, but would lock closed the other seven valves above it. After the vessel has been passed below the gate, the handle may be reversed releasing the lever and locking three switches. In case a large vessel is to be locked through, the interlocks on the intermediate gates can be made ineffective by the operation of a Yale lock which uncouples a clutch and disconnects the central switch from the operating mechanism.

To obviate the possibility of flooding the locks when valves are in a certain position, diagonal interlocking is introduced between the gate valves of the side wall and those of the middle wall a lock length away. This interlocking between valves diagonally across a lock when the cylindrical valves are open is needed to prevent the flow of water from, say, the upper lock by way of a side wall culvert to the middle lock, thence by way of the middle wall culvert to the lower lock, thus allowing an operator through carelessness to flood the lower lock walls. If the cylindrical valves of a certain lock are closed, the interlock is not needed on the gate valves of that lock; and since such interlock would interfere with the proper use of the valves of its twin lock on the other side of the middle wall, this interlock is automatically removed when all ten cylindrical valves are closed on the particular lock in question, and is automatically applied again if one or more of the ten cylindrical valves is opened. Furthermore, the valves of the side wall immediately at the gate which is being moved, will be open to equalize the water level, and diagonal interlocking will prevent the opening of the middle wall valves a lock length above or below the gate being moved. Each of the four valves of such a group has independent control, their control switches being so interlocked that either pair may be opened and left open as guard valves, the interlocks becoming effective when the operator tries to open the first valve of the second pair. In addition to these pairs of valves in parallel, each pair is duplicated at each change of level from one lock to the next.

All of the lock machinery motors, control panels, centralized control-boards, power station generating apparatus, switchboards, transmission line substation equipments, etc., were manufactured by the General Electric Co. The specifications for the entire generating, lock-controlling and distribution system for operating the Panama Canal were prepared under the supervision of Mr. Edward Schildhauer, electrical and mechanical engineer, Isthmian Canal Commission, assisted by a staff of able electrical engineers.

* * *

A remarkable exhibition of engine endurance was recently made by the Moline Automobile Co. in New York City under the auspices of the Automobile Club of America. A Moline-Knight four-cylinder motor was put on the testing block late in December and run continuously for two weeks—336 hours—without adjustment of the motor, carbureter, spark plugs or magneto at 1100 revolutions per minute. It developed thirty-eight horsepower and ran at a rate that would have carried it 14,700 miles on the level at forty-five miles an hour. It would have steadily climbed an eight per cent grade 10,000 miles long at twenty-seven miles an hour, or a mountain 800 miles high. At the end of the run the speed was increased to 1682 revolutions per minute for one hour, developing 53.6 horsepower. The engine was then taken apart and exhibited at the Auto Show. The parts showed very little evidence of wear. The test demonstrated that a properly proportioned motor well lubricated should have a long life and that it is the most dependable part of the modern motor car.

* * *

A petition has been presented to the German Reichstag, signed by some two hundred and fifty commercial and industrial organizations, asking their government to take steps toward the introduction of a universal international two-cent letter postage, and to endeavor to have this adopted by the International Postal Congress in Madrid next year.

CUTTING POWER OF LATHE TURNING TOOLS*†

INFLUENCE OF SPEED, DEPTH OF CUT, FEED, SHAPE, AND PHYSICAL PROPERTIES OF METAL

The question of the definite measure of the output of work or removal of material of which lathe tools are capable, is one about which there is very little information readily available, and it it was for the purpose of determining the performance of cutting tools over a fairly wide range of working conditions and of deducing therefrom some practical

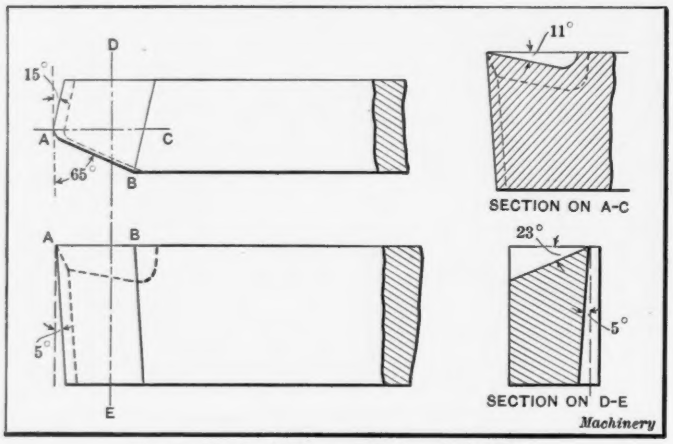

Fig. 1. Standard Shape of Tool used for Tests

results that the experiments described in the following were made. The object of the tests was to determine to what extent the output of both high-speed and ordinary carbon-steel tools is affected by such elements as cutting speed, depth of cut, feed of tool, shape of tool nose and physical properties of the metal upon which the cutting tool is acting. The question of the association of a high speed and a light cut *versus* a low speed and heavy cut received particular consideration in order to find the relation between these two factors and the maximum output.

Owing to the extensive use of turning tools of high-speed steel at the present time, especially when the cutting speed is an important consideration, the results of the tests made with carbon-steel tools have been omitted in this abstract.

Tools used for Tests—Test-bars

The high-speed steel tools tested were made from ¾- by ½-inch bars and were about 8 inches long. The shape of the tool used for the first series of tests is shown in Fig. 1. The

TEST-BARS FOR HIGH-SPEED STEEL TOOL TESTS

Physical Properties			
Letter of Identification	Breaking Load in Tons per Square Inch	Elongation, Per Cent	Compressive Load in Tons per Square Inch
A	27.2	28.4	81.2
B	33.5	21.7	90.0
C	50.5	12.0	126.4

Chemical Composition						
Letter of Identification	Carbon	Silicon	Manganese	Sulphur	Phosphorus	Grade of Steel
A	0.29	0.100	0.42	0.037	0.028	Mild
B	0.39	0.075	0.50	0.030	0.038	Medium
C	0.60	0.249	0.83	0.053	0.030	Hard

Machinery

tools were of high-grade steel and the ends were shaped entirely by grinding in a universal tool grinder. They were then hardened according to the directions of the maker. These tools were of the same shape and size as those used for the carbon-steel tool tests so that the results in each case could be compared.

The tests were made on a large electrically driven experimental tool-testing lathe installed in the machine tool laboratory of the University of Sheffield. The test-bars were three in number and of different chemical compositions and physical properties, as shown by the accompanying table.

Their approximate original dimensions were: Length, 9 feet 6 inches; diameter, 1 foot 8 inches. The meaning of the identification letters is as follows: A, mild steel; B, medium steel, and C, hard steel.

With the high-speed steel tools it was found possible to obtain a definite point at which the tool failed to cut; this is the point at which the cutting edge collapses, and instead of continuing to cut causes the surface of the bar to become polished. The exact instant at which each tool broke down or began to produce this polished surface was observed and from this the durability of the tool was determined. (The method adopted for carbon-steel tools involved a microscopic examination of the cutting edge to determine the amount of bluntness or wear, this being found the only possible way of establishing a standard for measuring the working life of the tool.)

Standard for Duration of Test

One hour was selected as a convenient value for the standard life of the tools used in these tests, although in machine

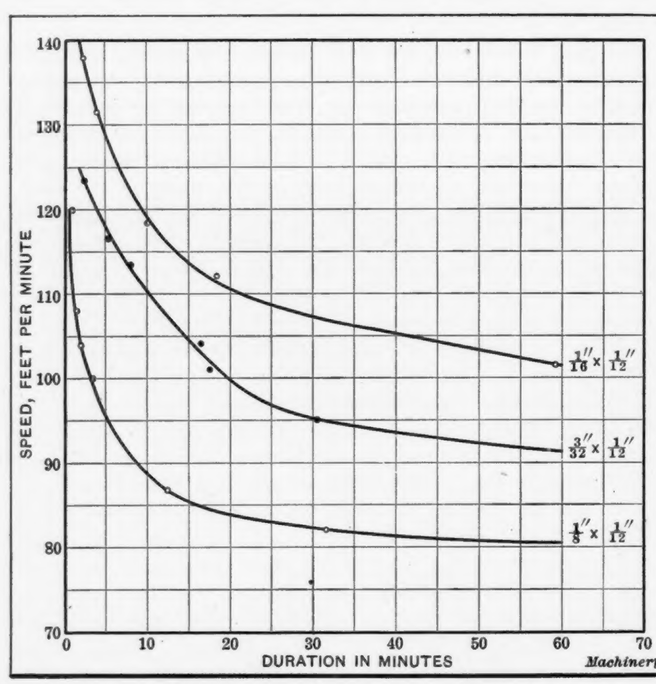

Fig. 2. Cutting Speed and Duration Tests for Varying Areas of Cut—High-speed Tools cutting Mild Steel

shops high-speed tools usually run a much longer period than this before resharpening, and the curves of performance seem to suggest that this practice has a reasonable basis, since the cutting speed which corresponds to a life of sixty minutes is, in practically every case, only about 5 or 10 per cent greater than that which will allow a tool to last for three or four hours.

The failure of a high-speed turning tool working under normal conditions is, in most cases, brought about by the fusing of the nose due to the heat generated as the result of friction. The friction is due to the rubbing of the chip on the upper lip of the tool as it passes off from the work. This rubbing action frequently causes a pit or hollow to be worn out of the upper face or lip of the tool just in front of the cutting edge. There is also friction due to the cutting action of the tool as it traverses the work in a line parallel to the axis. When the tool is worked under conditions which are not excessively severe, the heat generated at the nose of the tool is conducted away as fast as it is generated, and thus the nose is not subjected to overheating; but if the cutting speed

* Abstract of paper presented before the Institution of Mechanical Engineers, at Manchester and London, by Prof. William Ripper and G. W. Burley of the University of Sheffield.

† See also the series "On the Art of Cutting Metals," published in MACHINERY from January to August, 1907, inclusive.

and area of cut are such as to generate heat faster than the tool can conduct it away, fusing and breakdown at the nose takes place. Moreover, as the work proceeds, the tool accumulates heat from the nose backward, and the rate of flow or conduction of the heat away from the nose correspondingly decreases, with an increasing tendency to accumulation of heat at the nose.

The data taken during the tests include the circumferential or cutting speed, the depth of cut, the feed per revolution, the power-input to the motor on light load at the cutting speed selected, the time of starting the cut, the power-input to the motor during the actual cutting, and the time at which the tool failed. The tools were tested for the following areas of cut on each bar. Depth of cut, 1/16, 3/32 and 1/8 inch; feed per revolution for each depth of cut, 1/30, 1/20, 1/12 and 1/8 inch, respectively.

Relation between Cutting Speed and Durability of Tool

Altogether, about two hundred tests were made, the duration of each test varying from one minute to 70 minutes.

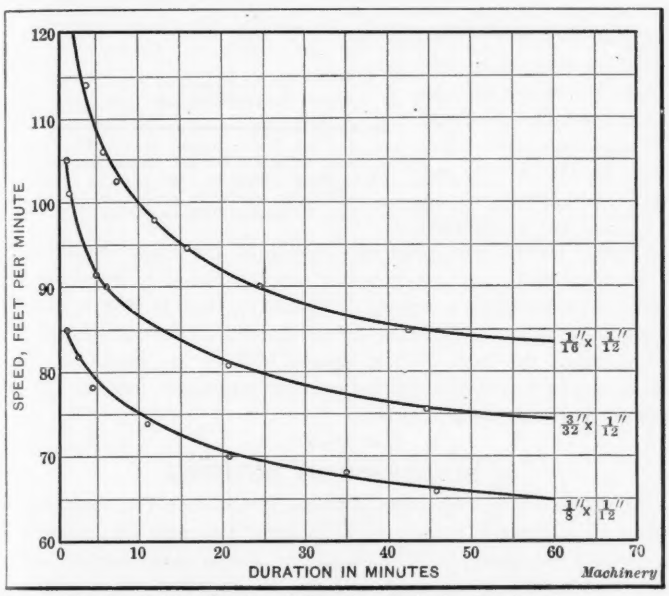

Fig. 3. Cutting Speed and Duration Tests for Varying Areas of Cut—High-Speed Tools cutting Medium Steel

For each area of cut or combination of depth of cut and feed per revolution, data for a cutting-speed-duration curve were obtained and the curves shown in Figs. 2, 3 and 4 were plotted. Fig. 2 is for mild steel (Bar A); Fig. 3 for medium steel (Bar B); and Fig. 4 for hard steel (Bar C). The curves are for a feed of 1/12 inch per revolution of the test-

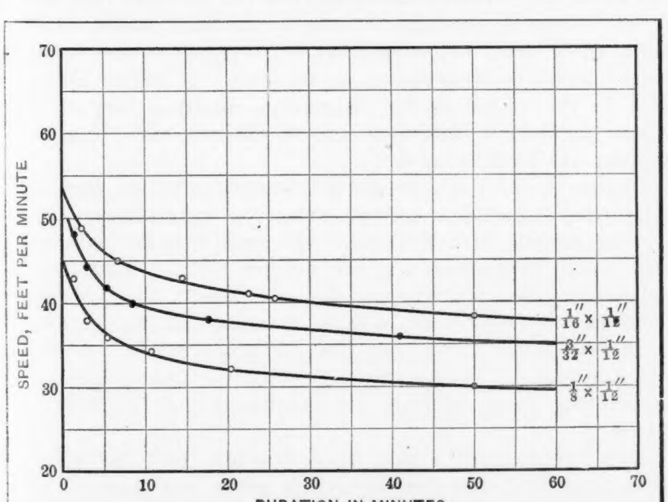

Fig. 4. Cutting Speed and Duration Tests for Varying Areas of Cut—High-speed Tools cutting Hard Steel

bar, the depth of cut, in each case, being given at the end of the curve. These curves show the effects of the hardness of the bar and area of the cut on the cutting speed, and the relation between the cutting speed and the life of the tool up to the point of failure. They further indicate that at high cutting speeds the durability of the cutting edge is very short, but that, as the rate of cutting is reduced to a speed which gives a durability of 40 or 50 minutes, the tool then continues to cut for a more or less indefinite period as indicated by the change of the curves toward the horizontal. If this speed,

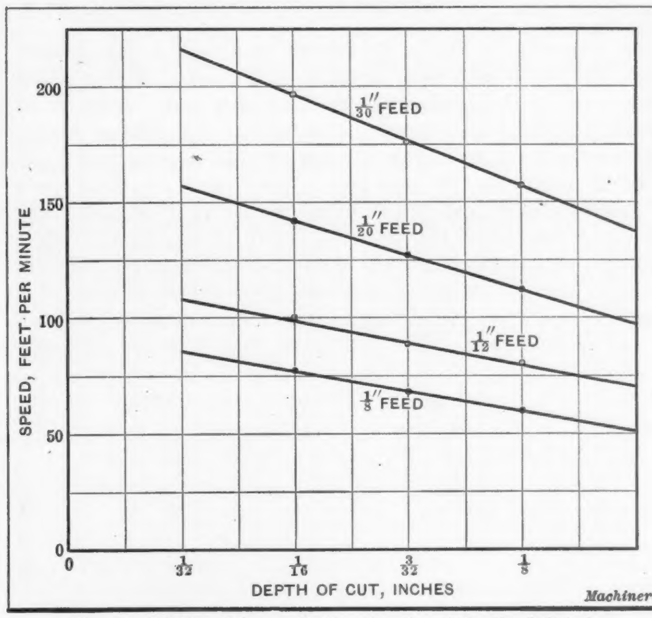

Fig. 5. Relation between Cutting Speed and Depth of Cut for Varying Feeds—Standard Life of Tool, Sixty Minutes

however, is exceeded by from 10 to 15 per cent, the life of the tool is rapidly shortened. The average relation between the cutting speed S and the life of the tool M, in minutes, for any given area of cut between durations of 10 and 60 minutes, is represented approximately by the formula:

$$SM^{\frac{1}{12}} = \text{constant.}$$

The value of the constant depends upon the quality of the steel being turned and upon the area of the cut. The rela-

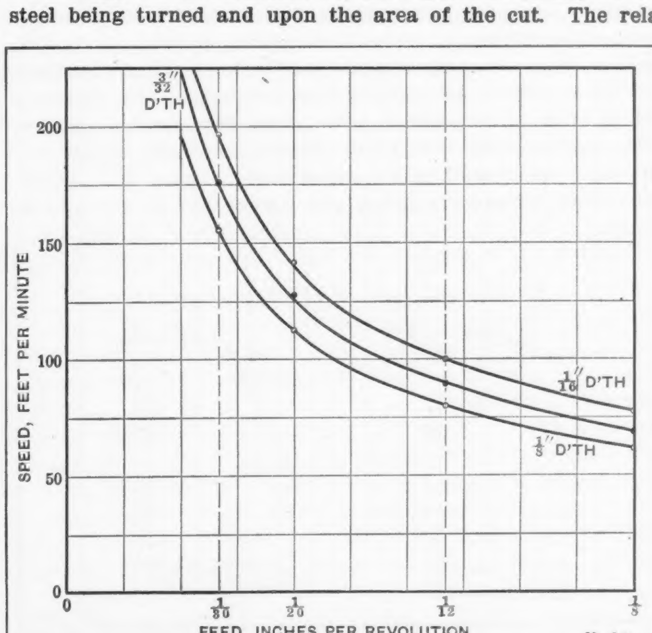

Fig. 6. Relation between Cutting Speed and Feed for Varying Depths of Cut—Standard Life of Tool, Sixty Minutes

tion between these two quantities, as determined by Mr. F. W. Taylor, for high-speed turning tools is

$$SM^{\frac{1}{8}} = \text{constant.}$$

Relation between Cutting Speed and Area of Cut

For each test-bar, the relation between the cutting speed and the associated area of cut for a standard life of 60 minutes was determined, the data in regard to the cutting speed being drawn from the curves of which Figs. 2, 3 and 4 are representative. Contrary to the experience and views of Dr. Nicolson, and in agreement with those of Mr. F. W. Taylor, it was found that the cutting speed did not depend only upon the area of cut, independently of its component factors, but that it also depended upon the depth of cut and

feed per revolution, in two different ways, as shown by the curves Figs. 5 and 6. Fig. 5 shows the relation between the cutting speed, for the standard tool life, and the depth of cut for the various speeds adopted; whereas Fig. 6 shows the relation between the cutting speed and the feed per revolution for varying depths of cut, the curves referring to test-bar *A* in each case.

By referring to Fig. 5, it will be seen that a cut 1/8 inch deep, with 1/20 inch feed, is taken at a greater cutting speed than a cut 1/16 inch deep with 1/10 inch feed, which is of equal area but less efficient as to output. A similar deduction can be made from Fig. 6, where it will be seen that a cut 1/8 inch deep with 1/24 inch feed is taken with a cutting speed of 125 feet per minute, whereas for a cut 1/16 inch deep with 1/12 inch feed the speed is 100 feet per minute. Some explanation of this is indicated by the illustrations *A* and *B* in Fig. 7. In each of these views a tool having a nose of standard shape is represented taking a cut, the area of which is the same in each case. At *A* the depth is one-half that at *B*, but the feed per revolution is twice as great. It will be noticed that the length of the cutting edge which is in contact with the work at *A* is considerably less than at *B;* hence, in the latter case there is a much larger cooling area back of the cutting edge to conduct the heat away as it is generated. Therefore, other things being equal, the rise in temperature of the cutting edge, in the second case, will not be so rapid as in the first; hence, a higher cutting speed can be employed with the tool having a longer cutting edge in contact with the work.

Output of Turning Tools

The standard output of a turning tool is defined in these tests as the number of cubic inches which the tool will remove during the standard life of 60 minutes. The maximum output or removal of metal is associated with the lowest cutting speed with which, for a standard life of 60 minutes, the heaviest depth-feed combination is associated; the greater influence is, of course, on the side of the depth. Thus, with a depth of cut of 1/8 inch and a feed of 1/20 inch per revolution, the volume of metal removed in 60 minutes is 504 cubic inches, whereas, with a 1/16-inch cut and 1/10-inch feed the output is 405 cubic inches per hour. This shows a gain of about 25 per cent in favor of the deeper cut with a reduced cutting feed. This law applies generally to all the bars and speed-depth-feed combinations; hence it may be stated that for the maximum tool output, the area of cut is

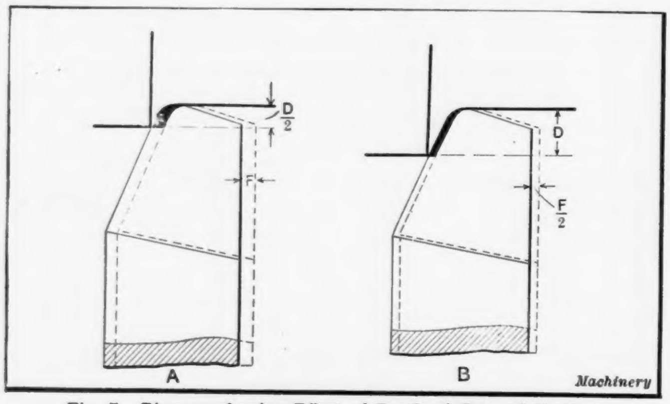

Fig. 7. Diagram showing Effect of Depth of Cut and Feed on Length of Cutting Edge in contact with Work

a maximum which the tool will stand without fracture, with the depth of cut a large factor and the associated speed correspondingly low.

To determine the effect of a change in the relation between the cutting edge of the tool and the axis of the test-bar, tools having shapes as indicated by the dotted and full lines in Fig. 8 were used. The same conditions as to the test were adopted in each case. It was found that for a given depth of cut the cutting speed was directly proportional to the length of the cutting edge of the tool in contact with the work; that is, a proportionately greater output with a tool having a longer cutting edge was obtained. In all other respects the angles of the tools were the same.

For an area of cut 1/8 inch by 1/12 inch, the cutting speed which would allow a tool to last one hour was found to be 78 feet per minute for high-speed steel, and 8 feet per minute for plain carbon steel, on a bar having a tensile strength of about 25 tons per square inch; that is, the high-speed tool removed ten times as much metal as the plain carbon tool in a given time.

Relation of Motor Power to Output

To determine the relation existing between the area of cut, the speed and the actual horsepower required, tests were made on different bars with various depths of cut and feeds and their associated cutting speeds. The power consumption was obtained by taking voltmeter and ammeter readings when the cut was in and also when it was not in, the speed being the same in each case. The net horsepower or power required for the actual cutting was calculated from the difference between the two readings. The results showed that the actual net horsepower required to remove a given number of cubic inches per hour is a constant for each quality of steel machined. In other words, the output per horsepower-hour is practically a constant quantity; that is, for a given output per hour nothing is gained in net power consumption by altering the ratio of the area of cut to the speed of cutting, the net horsepower being approximately directly proportional to the output only.

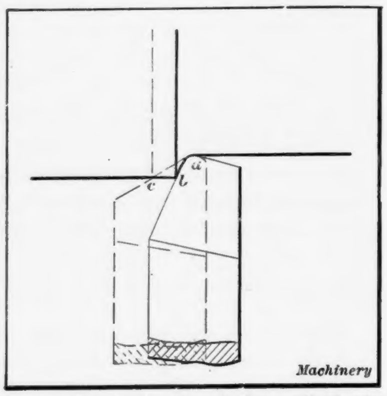

Fig. 8. The Tests showed that a Tool with a Short Cutting Edge a-b in contact with the Work cannot be used with as High a Cutting Speed as a Tool having a Longer Edge as at a-c

* * *

A SUGGESTION SCHEME

About two years ago the Automatic Electric Co., manufacturer of automatic telephone apparatus, Chicago, Ill., adopted a suggestion plan for its employes which has worked out satisfactorily. A suggestion form is supplied upon which all foremen are required to report at least once a week. They may send in one or a dozen of these forms, but one is the minimum, and it must either give a suggestion or the words "No suggestion to make this week." When a suggestion is received, the factory superintendent notes it and refers it to an engineer, who makes an investigation. The engineer obtains opinions from the employes affected and reports as to the changes in equipment necessary to put the plan into operation, giving an estimate of the saving that would result. With these data, the suggestion is returned to the factory superintendent for approval or rejection. A notice is then sent to the maker of the suggestion, advising him of the action taken and informing him of the reasons if his suggestion has been rejected.

During the past six months a modification of the plan has been tried, whereby a special subject for suggestions during certain periods is announced. The employes are informed that while suggestions on any subject will be appreciated, special attention is invited to the one named. The following subjects have been dealt with in this way. 1. Safety First. 2. Water, Light, Power and Gas. 3. Bonus Work. 4. Care of Materials. 5. Inspection. 6. Material and Finish. 7. Scheduling Work, Chasing, Requisitioning and Transferring Stock.

Substantial benefits have been realized from the suggestion plan, for while the company's plant was planned and systematized by efficiency experts of recognized ability, it has been found that the "man on the job" is often able to improve the details of the general system, thus materially adding to the efficiency of the methods employed and eliminating many causes of waste and expense. The plan has the additional value of giving employes a keener interest in their work and providing a useful channel for the criticisms always offered by workmen.

GAGING WATCH ESCAPEMENTS*

A COMPLETE SET OF GAGES FOR WORK OF UNUSUAL REFINEMENT

BY DOUGLAS T. HAMILTON†

The detached lever escapement is considered by horologists to be one of the most difficult parts of a watch movement to manufacture, because of the important function it fills in the proper timing of a watch. It transforms the rotary motion of the train of wheels into the vibratory movement of the balance, and at the same time acts as a brake to prevent the watch mechanism from "running away," retarding the motion of the wheels, and imparting the correct movement to the hands on the dial. To design an escapement properly requires not only considerable experience in this work, but also a clear understanding of the functions that this important part of a watch has to fill. The conditions are never ideal, so a compromise must always be made in order to obtain an escapement which fills the most important requirements.

As the functions and requirements of a watch escapement were described in an article on "Watch Movement Manufacture—1" which appeared in the May, 1912, number of MACHINERY, it will not be necessary to enlarge on them here, the chief aim of this article being to illustrate and describe the manner in which theoretical requirements obtained by calculation are brought down to a practical working basis. This is the problem with which horologists always experience difficulty. Drawings are first made on a scale of fifty to one, and all dimensions are obtained mathematically

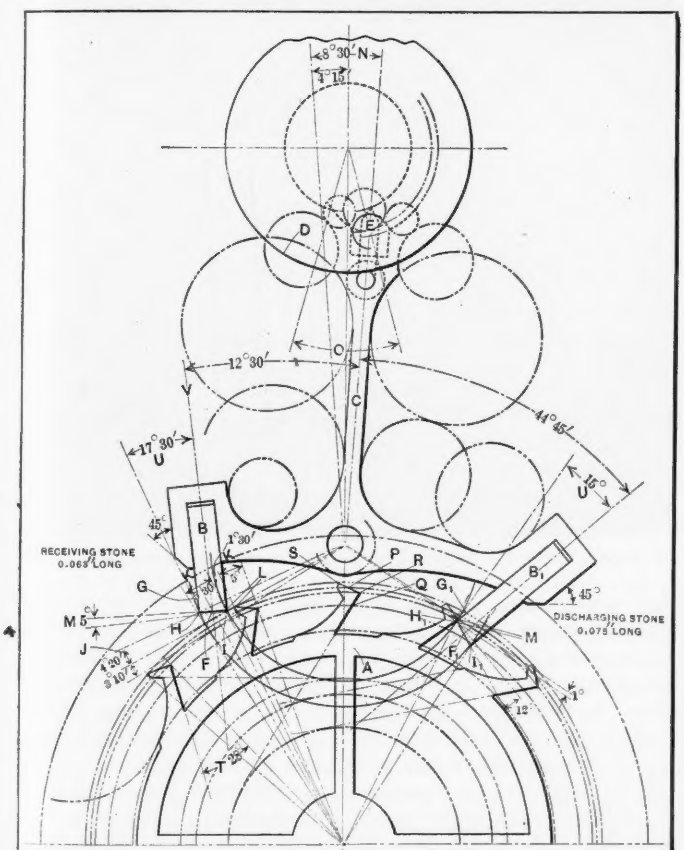

Fig. 1. Diagram illustrating Method of analyzing a Detached Lever Watch Escapement

where possible. Reducing and producing a watch escapement with the accuracy defined by a mathematical calculation is not an easy matter.

The first step in producing a watch escapement, as mentioned, is to lay it out on paper on an enlarged scale of fifty to one, and then by means of certain parts outlined on tracing cloth, to study the movements in the manner that they take place in the watch. The proper manufacture of an escapement does not end here, and in fact the most difficult work—producing the various parts correctly—is still to follow. Several schemes are adopted in different watch making plants to check up the machining operations in order to determine whether they have been properly executed or not.

The Projector Method

One method which is used to a considerable extent is to employ a projector (an instrument designed on the principle

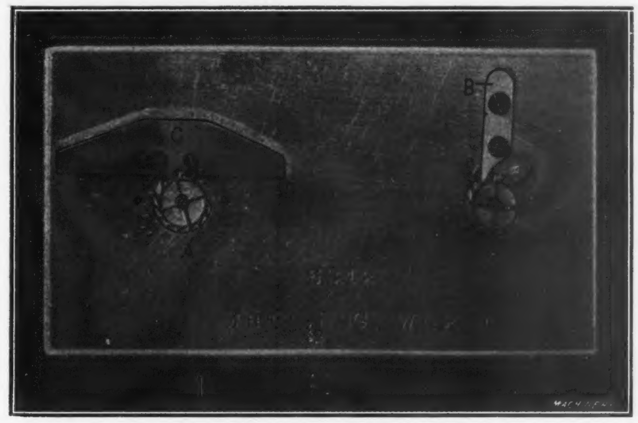

Fig. 2. Gage for measuring Different Angles on the Escape-wheel Teeth

of the magic lantern) to project and enlarge the escapement in order to determine if the machining operations have been correctly done. The escapement to be projected is placed on a pane of glass set in the frame of the projector where it is held flat against the surface of the glass by a spring. The projector is then placed in a dark room in such a relation to a screen as to obtain an enlargement of the escapement of ten diameters. The screen used generally consists of a sheet of drawing paper and the outine of the projected escapement is traced with a pencil. This sheet is then removed and the various functions, angles, etc., of the escapement are measured on this enlarged scale. The drawing paper may be replaced by a photographic plate and a photograph taken, but this process requires considerable time and is very seldom used except in horological schools, when a large number of copies are to be distributed to the pupils to study. Manufacturers, as a rule, simply make a drawing of the projection.

The Microscope with Illuminated Chamber

The second method consists of a microscope with an illuminated chamber, mounted in such a manner as to give an enlargement of ten diameters and provided with a prism and a mirror, enabling the object to be set outside the microscope in order that its projection may be traced. The microscope is furnished with a screw, the barrel of which is provided with 100 divisions and enables measurements to be obtained to one thousandth millimeter. The lever escapement thus enlarged ten times with the aid of the microscope is then analyzed. The calibrated screw is used to check up the dimensions.

Method of Gaging Escapements Employed by the South Bend Watch Co.

The third method, and the one to be described here, is that used by the South Bend Watch Co., South Bend, Ind. This method consists in using gages which are very accurately made for measuring the various functions and members of a watch escapement. While the two methods previously described would seem to be scientific in their exactness, there is always a question in the mind of the mechanic as to the practicability of this procedure in work of an interchangeable character. There is little, if anything, to be gained by using methods of measurement which are much more accurate and worked down to greater degree of refinement than it is possible to obtain when manufacturing the parts on a commercial basis. For instance, by means of the microscope and illuminating chamber it is possible to obtain dimensions to within one thousandth millimeter. To duplicate this ac-

* For information on watch making previously published in MACHINERY, see "Watch Movement Manufacture" in the May and June, 1912, numbers, and articles there referred to.
† Associate Editor of MACHINERY.

curacy on thousands of parts produced with cutters in a mechanically operated machine is practically an impossibility. One piece could probably be made, but the slightest wear on the cutters would mean that this refinement would be lost. Gages can be made of sufficient accuracy to check up any variations in the work that may occur due to the wear of cutters or improper setting. Furthermore, the gages are at all times at hand to test the parts and determine just as soon as a slight error creeps in. If gages were not furnished it would be necessary to test the parts at short intervals as previously described, which would not only be impracticable but would not fill the requirements of the case.

In order to make the following description of the gages clear, reference should be made to Fig. 1 in which the various members of a detached lever escapement that require consideration are clearly outlined. These various members are indicated by letters, the functions and names of which are as follows: *A*, escape-wheel; *B*, receiving pallet stone; B_1, discharging pallet stone; *C*, fork; *D*, roller; *E*, impulse pin; *F*, impulse face of receiving stone; F_1, impulse face of discharging stone; *G*, locking face of receiving stone; G_1, locking face of discharging stone; *H*, locking corner of receiving stone; H_1, locking corner of discharging stone; *I*, releasing corner of receiving stone; I_1, releasing corner of discharging stone; *J*, lift of pallet; *K*, circular impulse; *L*, drop; *M*, lock; *N*, arc of impulse fork; *O*, arc of impulse of roller; *P*, impulse face of escape wheel tooth; *Q*, locking face of escape wheel tooth; *R*, locking corner of escape-wheel tooth; *S*, releasing corner of escape-wheel tooth; *T*, locking angle of escape-wheel tooth; and *U*, draft angle of pallet stone.

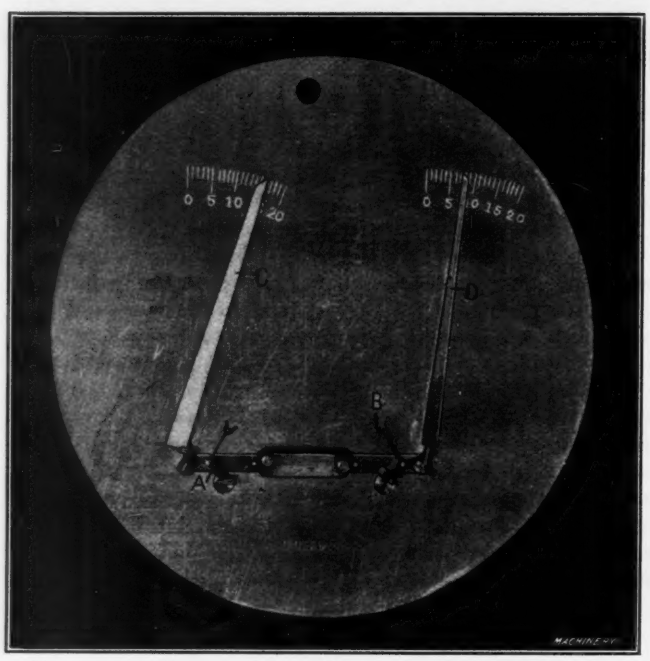

Fig. 3. Gage for measuring Position of the Forks, Pallet Stones, etc., of Detached Lever Escapement

Each one of these conditions and functions of the detached lever escapement must be checked up after machining in order to determine if the requirements secured by graphic methods and mathematical calculations have been obtained. The first gage which is used is shown in Fig. 2; the object of this is to measure the different angles on the escape-wheel teeth. It measures the angle that the impulse face *P* of the escape-wheel tooth makes with a tangent to the periphery of the escape-wheel at the releasing corner *S*; it measures the angle that the locking face *Q* of the escape-wheel tooth makes with a radial line drawn from the center of the wheel to the locking corner *R*, and it also measures the periphery diameter of the escape-wheel teeth. Straightedges *B* and *C* are used to measure the angles of the escape-wheel teeth and are set by plugs placed in the centers of the recesses, the radii of these plugs being the sines of the angles to be measured. When it is stated that one ten-thousandth inch of variation can be clearly indicated on a gage provided with knife-edge straightedges similar to that furnished on this gage, it will be evident that this method of gaging is practically as exact a method as it is possible to obtain; at least, it is close enough to check up any errors in machining which would affect the efficient working of the escapement.

The circular gage shown in Fig. 3 in which two forks *A* and *B* are located on pins is used with the aid of straightedges *C* and *D* to measure the draft angle *U* of the pallet stone, and also the angle that the impulse face of the stone makes with a line *V* passing through its center. (See Fig. 1.) This gage also measures the distance from the center of the pallet to the locking corners *H* and H_1 and the releasing corners *I* and I_1 of the pallet stones. It will be seen in this particular case that the draft angle of the receiving stone measures 15¾ degrees, and the draft angle of the discharging stone 7¼ degrees.

The third circular gage shown in Fig. 4, upon which the completed escapement is held, is used for the following measurements: Impulse face *F* and F_1 of pallet stones; the drop *L*; the lock *M*; the arc of impulse *N* of the fork; the arc of impulse *O* of the roller; the recoil of the escape-wheel in unlocking the slide or run of the escape-wheel; and the side shake of the impulse pin in the fork slot. These circular impulses of both wheel teeth and stones are taken as angular measurements from the center of the escape-wheel. The three needles, the correct positions of which are indicated on this gage, give readings as follows: The circular impulse of the

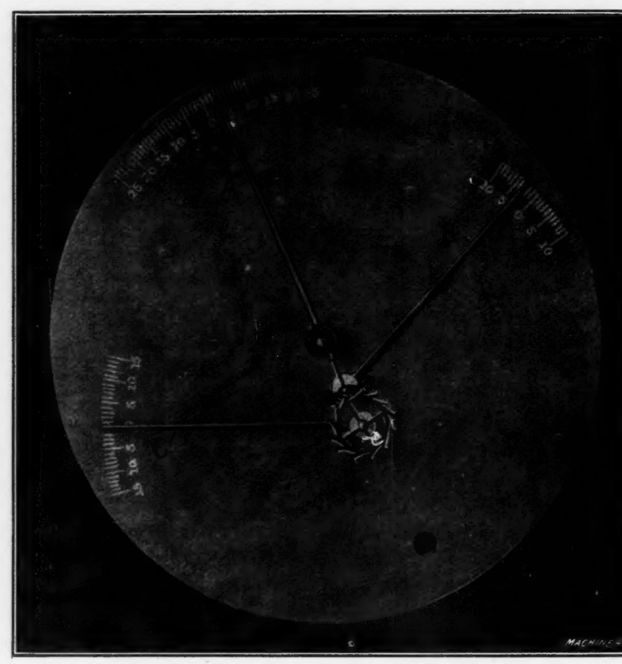

Fig. 4. Gage for measuring a Complete Assembled Escapement

pallet stone is 5½ degrees; the circular impulse of the wheel tooth 5 degrees; the drop ½ degree; and the lock 1 degree. The positions of the needles *A*, *B* and *C*, as shown in Fig. 4, have a meaning only when compared with their positions before the action of the escapement took place. The office of these needles, therefore, is to measure the angular distance at the beginning and at the end of each action.

By the use of these three gages all the functions of the detached lever escapement that it is desirable to know may be measured. An escapement can be taken from a watch and measured at every particular point. Furthermore, these gages are not made until an escapement has been produced which works as efficiently as it is possible to make it; then the various parts of the escapement are removed and the gages made to them, ideal conditions being realized in this way. It is also possible by the use of these gages to construct a perfect working escapement from a very much enlarged drawing with the positive assurance that it will be an exact miniature. This latter method, looking at it from a mechanical standpoint, would appear to be much more practical and exact than those previously described.

* * *

Telegraph poles of glass are being used in Germany with success. Woven wire is imbedded in the molten glass to reinforce the pole.

PROFIT-SHARING PLAN OF FORD MOTOR CO.

Probably no wage change made by a manufacturing concern has ever attracted more widespread attention than the profit-sharing plan of the Ford Motor Co. of Detroit, Mich. Henry Ford, head of the company, announced January 5 that his company would give to the employes $10,000,000 of the profits of the 1914 business, the payments to be made semi-monthly and added to the pay checks.

The factory will be run continuously instead of only eighteen hours a day, giving employment to several thousand more men by employing three shifts of eight hours each, instead of only two nine-hour shifts, as heretofore. A minimum wage scale of $5 per day will be established. Even the floor sweepers are included. Before any man in any department of the company who does not seem to be doing good work shall be discharged an opportunity will be given to him to try to make good in every other department. No man shall be discharged except for proved unfaithfulness or irremediable inefficiency.

The company's financial statement of September 20, 1912, showed assets of $20,815,785.63 and surplus of $14,745,095.57. One year later it showed assets of $35,033,919.86 and surplus of $28,124,173.68. Dividends paid out during the year, it is understood, aggregated $10,000,000. The indicated profits for the year, therefore, were about $37,597,312. The company's capital stock, authorized and outstanding, is $2,000,000. There is no bond issue.

About ten per cent of the employes, boys and women, will not be affected by the profit sharing, but all will have the benefit of the $5 minimum wage. Those among them who are supporting families, however, will have a share similar to the men of more than twenty-two years of age. In all, about 26,000 employes will be affected. Fifteen thousand are now at work in the Detroit factories. Four thousand more will be added by the institution of the eight-hour shift. The other seven thousand employes are scattered all over the world, in the Ford branches. They will share the same as the Detroit employes.

"It is our belief," said James Couzens, treasurer of the company, "that social justice begins at home. We want those who have helped us to produce this great institution and are helping to maintain it to share our prosperity. We want them to have present profits and future prospects. Thrift and good service and sobriety, all will be enforced and recognized. Believing as we do that a division of our earnings between capital and labor is unequal, we have sought a plan of relief suitable for our business. We do not feel sure that it is the best, but we have felt impelled to make a start, and make it now. We do not agree with those employers who declare, as did a recent writer in a magazine in excusing himself for not practicing what he preached, that 'movement toward the bettering of society must be universal.' We think that one concern can make a start and create an example for other employers. That is our chief object."

"If we are obliged," said Mr. Ford, "to lay men off for want of sufficient work at any season, we purpose to so plan our year's work that the lay-off shall be in the harvest time, July, August and September, not in the winter. We hope in such case to induce our men to respond to the calls of the farmers for harvest hands, and not to lie idle and dissipate their savings. We shall make it our business to get in touch with the farmers and to induce our employes to answer calls for harvest help. No man will be discharged if we can help it, except for unfaithfulness or inefficiency. No foreman in the Ford Motor Co. has the power to discharge a man. He may send him out of his department if he does not make good. The man is then sent to our 'clearing house,' covering all the departments, and is tried repeatedly in other work, until we find the job he is suited for, provided he is honestly trying to render good service."

It is impossible for anyone to accurately predict what the ultimate effect of this remarkable profit-sharing plan will be on the industrial conditions of the United States. Let us hope that it marks the dawning of a brighter day when labor and capital will share more equally in the profits of industry, but that such a consummation will directly follow is very doubtful. Whatever follows, one fact stands out clearly: The Ford Motor Co. has stamped itself and its product indelibly upon the minds of all classes the country over.

* * *

BRIEF HISTORY OF THE MOTOR CAR

An interesting description of early types of motor cars, and the industry's development from the seventeenth century, has been written by Walter H. Whiteside, president of the Stevens-Duryea Co. An abstract of the article follows:

The first experiments with "horseless carriages" that met with any degree of success were made in the seventeenth century, when Johann Haustach of Nuremberg constructed a carriage propelled by springs. There was no steering device, but the car would travel in a straight line when wound up. During the same period vehicles to which sails were attached were used in Holland. In 1619 another spring-driven carriage referred to in the patent paper as a "cart without horses," was patented in England, and in 1644 a French patent was issued on a four-wheel carriage propelled by foot-power. In 1748 a carriage driven by clockwork was exhibited before Louis XV of France. Several others experimented with spring drives up to the year 1800, but with little success.

Steam was first used in a road carriage in Pekin, China, in the year 1630. History credits Father Verbiest, a missionary, with achieving this feat. This was followed in 1680 by Sir Isaac Newton's steam carriage. In 1769 a steam gun carriage was built in France. It had three wheels, was driven by a two-cylinder engine, and traveled three miles per hour when loaded with 2½ tons. In 1787, Oliver Evans of Maryland invented a steam road wagon, and Nathaniel Reed, in 1790, constructed a combined road wagon and boat at Pecousic, Mass. These two men were the first ones to build steam carriages in this country that would successfully propel themselves. The first steam carriage in which the crankshaft was geared to the driving wheel was invented by Richard Trevithick in England in 1802. In 1831 a steam-driven carriage was operated between Cheltenham and Gloucester, England. This carriage could run twelve miles an hour, but the service was discontinued after four months, owing to public opposition. Walter Hancock established a steam omnibus line in 1829. His was the first chain transmission vehicle invented. In 1836 five of these carriages were operated between Paddington and Stratford, and, in twelve weeks, 12,760 passengers were carried. This line was practically forced out of business by the English government, because of a toll law with taxes so high that none could afford to run cars. This law arrested further development of the horseless carriage until its repeal in 1846.

In France in 1880 a steam carriage was built which, as late as 1895, ran 745 miles in 90 hours. In 1886 the first gasoline engines were used on road vehicles. These were the invention of Carl Benz and Gottlieb Daimler of Germany. In 1889 a two-cylinder engine was invented by Daimler; Messrs. Panhard and Levassor of Paris immediately acquired the patents and built around the engine the first gasoline motor car. The Panhard car was quickly followed by the Renault Freres and the Benz. To J. Frank Duryea belongs the distinction of being the first American to turn out a successful motor-driven vehicle. The first car was completed at Springfield, Mass., in 1891, and was equipped with a one-cylinder motor. In 1894 a vehicle propelled by a two-cylinder engine was built.

In view of the present magnitude of the automobile industry, it hardly seems possible that the first automobile factory in the United States was started only twenty-two years ago, this being the factory established by J. Frank Duryea at Springfield, Mass. Today there are over 500 factories with an estimated annual output of 350,000 cars.

* * *

The turbines which will drive the new mammoth Cunarder *Aquitania* will have a total weight of 1400 tons. There are over a million turbine blades in the rotors, the combined length of which is about 140 miles. The blades vary in length from 1½ to 20 inches.

A VISIT TO THE WINDSOR CLUB

It was real winter when I stepped from the train in Windsor, Vt., up among the Green Mountains. Ten inches of snow lay upon the ground and the thermometer was slowly climbing to the zero point from six degrees below. On the way over to the club-house, Mr. Gridley, the manager of the Windsor Machine Co., explained the why and wherefore of the company's plan. He said that when it was realized that the old plant was too small and that adjacent land was not available, the company had built the new plant at a more advantageous location near the railroad. The old building was left idle, and as a manufacturing plant of its size had no market in Windsor, the decision was made to turn it into a club-house for the employes and those of the town people who cared to use it. A very good reason for the establishment of the club-house, Mr. Gridley went on to say, was that good boarding houses in Windsor were scarce, and the prices asked for board were exorbitant. It thus became imperative, in order to keep good men at the works, to provide a satisfactory boarding place for them, so it was decided to establish this permanent club where such of the employes as desired could reside and get good accommodations at a reasonable price.

The first illustration shows the club buildings after they had been transformed from the old factory. The addition of a veranda and a front entrance greatly improved the appearance, and as soon as I had stepped in the front door I became aware of a real home atmosphere. The lobby walls and ceilings have been panelled with art-board, using the color scheme of red and white for the walls and brown for the ceiling. This treatment prevails throughout the building and it forms an ideal way of covering the unsightly walls of an old factory. An attractive feature of the lobby is the fireplace, in front of which a jolly group of the men was gathered.

Fig. 1. The Windsor Club—showing what can be done with an Old Factory Building

Passing out into the reading and writing room, I found a few of the men writing letters and others looking over copies of the current magazines. But before we could go farther, the call for dinner was announced and we entered the dining-room. This room, by the way, was formerly the lathe department of the old factory, but a new hard-wood floor, panelled walls and ceilings and modern lighting arrangements have given it an entirely different aspect. There are accommodations for seventy-five or eighty boarders; the bill-of-fare is good and low rates are charged. The ability of the chef was attested by the meal, and the sirloin steak served would have done credit to the best metropolitan hotel.

In fact, the dinner and the service were so good that I expressed a desire to look through the kitchen, so Mr. Gridley volunteered to take me out. Here are the latest types of cooking apparatus, steam kettles, hotel range, dish-washing machine, etc., and the bakery, which is adjacent, is also fully equipped. To supply ice for the eight- by twenty-foot refrigerator, an ice machine has been installed, and a glance into the ice-box showed how well the provisions are kept in condition for the dining-room.

From this point on, Mr. Cone, the factory manager, conducted me into the club-rooms proper. Mr. Cone has been especially interested in this feature of the project, and he explained as we were sitting in the arm chairs with which the main hall is furnished that the club features had as much to do with the success of the establishment as the hotel end of it. In this hall a dance is held once a week on which the interest of the entire town is centered. Besides, there are occasional concerts, and at the present time a lecture course is going on. The hall is attractively finished with white ceilings and walls and well lighted with electricity. More reading tables are provided here and except on dance nights the room has the appearance of a general recreation room. The superintendent of the club has his desk here and has a general oversight of all that goes on. A game of pool shortly after convinced me that the pool table equipment and accessories are first-class.

On the way out to bowl a few strings on the alleys, Mr. Cone showed me the modern laundry in which the needs of the hotel and club are cared for. The up-to-date washing machine and mangle comprise part of the equipment. Nearby are shower baths for the club members, which are greatly appreciated, especially during warm weather. When the company erected the new plant, a new power plant, heating and electric lighting equipment was installed. As the old apparatus was left in place in the old building, it was utilized. I found the bowling alleys, of which there are four, are of modern construction, regulation size and equipped with bottle, candle and duck pins. Rows of spectators' seats are provided at the rear and the alleys present an animated scene every evening. By providing features of this kind the management has assured that the leisure time of employes will be pleasantly and healthfully spent.

"The Windsor Machine Co.," said Mr. Cone, "gives employment to several hundred men, most of whom are skilled workmen who must naturally come from out of town." He stated that time after time they had secured good men whom they would have liked to retain but when those men found how poor the boarding accommodations of Windsor were, and how little was the chance for recreation, they soon left their jobs for others in larger cities. Since the institution of the club-house, the condition has changed and men are contented; in fact the club has proved to be a decided attraction for desirable men.

The fitting up of the club represents several thousand dollars expenditure, and though fourteen people are employed and it is open from six in the morning till eleven at night seven days in the week, it is practically self-supporting. The rates charged for board and room are remarkably low, considering the accommodations given. An excellent room with hot and cold water, including meals, costs $6.50 per week. The club also caters to the traveling public, automobile parties, etc., and for such the rate is $2.50 per day for board and room, and all guests are furnished with cards admitting them to the privileges of the club.

The dinner, inspection, bowling and chat made a pleasant evening all too short. I was conducted to a room on the second floor to spend the night. There are forty rooms and more are being constructed. They are all built in what was formerly the large second floor machine shop, and a new floor had to be laid, the walls sheathed and partitions put up. The connecting bath was a refreshing convenience that a traveler fully appreciates, and so comfortable was my bed that sound sleep was broken only when my next-door neighbor's alarm clock rang at 6:30. After a breakfast that well fortified one for the day's work, I bade adieu with reluctance to the Windsor Club, and returned to the grind of the great city.

C. L. L.

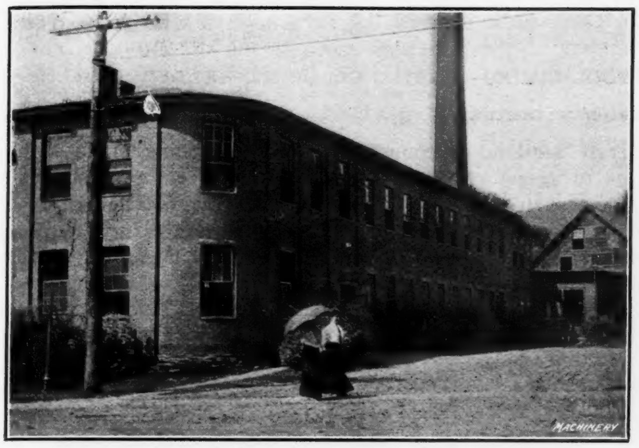

Fig. 2. The Old Factory before the Transformation

Fig. 3. The Club Members enjoy the Comforts of the Lobby

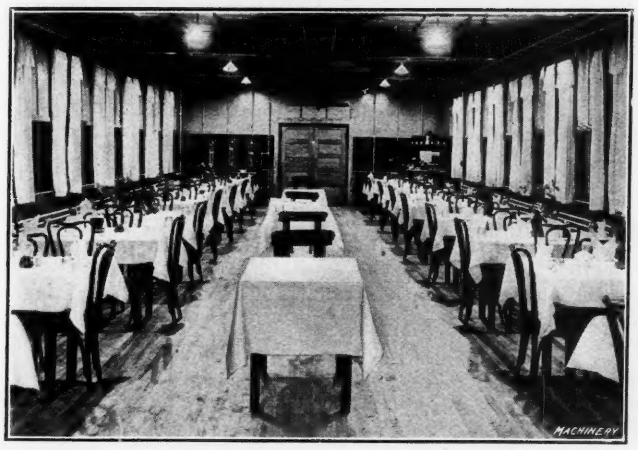

Fig. 4. A Fine Dining-room made from the Lathe Department

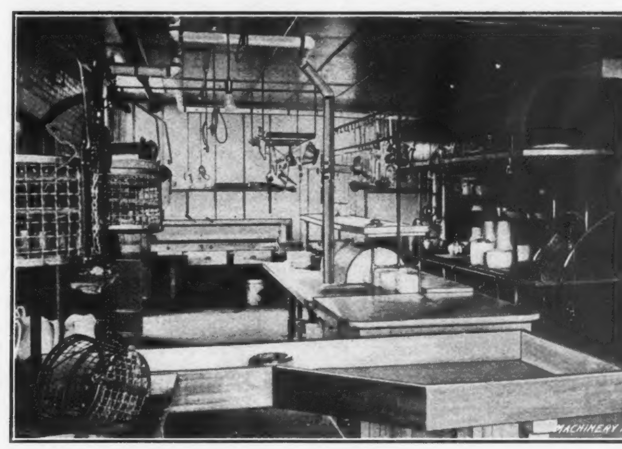

Fig. 5. The Chef has every Facility for preparing the Food

Fig. 6. The Recreation Hall is Large and Ideal for Dancing

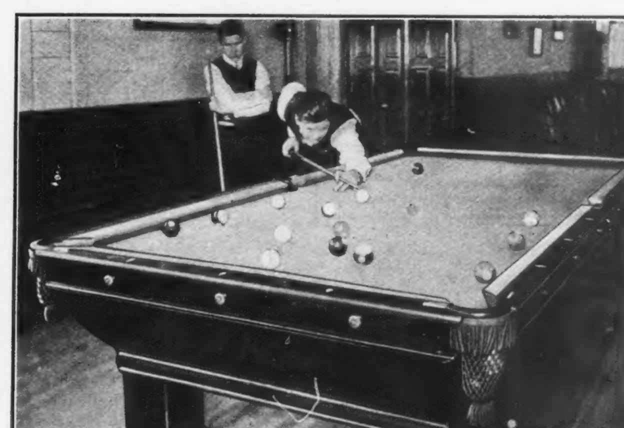

Fig. 7. Making a Critical Shot on One of the Pool-tables

Fig. 8. The Modern Bowling Alleys are Popular with the Members

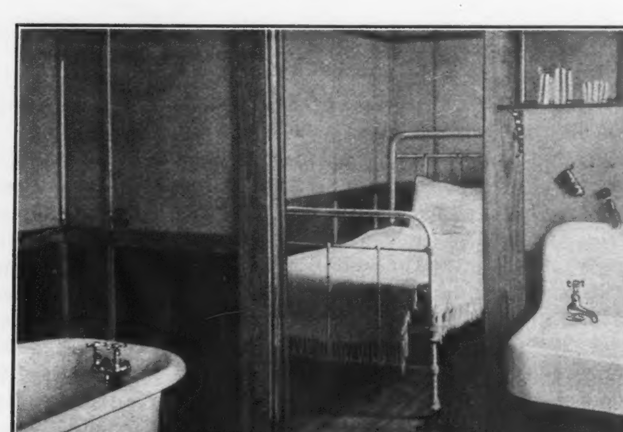

Fig. 9. My Room with its Private Bath was very Comfortable

COLD-HEADING—3

COLD-HEADING DIES AND TOOLS—POINTS IN THE TOOLMAKING—SETTING UP A COLD-HEADER

BY CHESTER L. LUCAS* AND E. W. DUSTON†

In the first two installments of this article published in the May and July, 1913, numbers of MACHINERY, the principles and different types of cold-heading machines were treated, together with the character of work for which each machine was adapted. In this number we will consider in detail the tools for solid- and open-die machines, including an outline of the operations connected with their making. As there are numerous little kinks and methods followed by individual heading die makers, it will only be possible to strike an average and outline the general processes of making the tool. As in other lines of toolmaking, no two workmen's ideas on a given set of tools will agree, although each may be right from his own point of view.

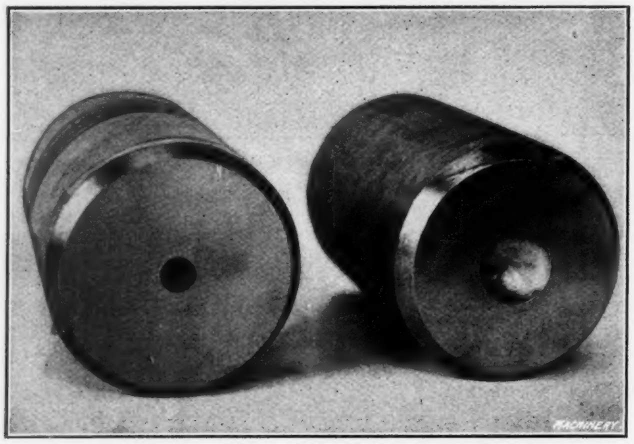

Fig. 28. A Pair of Solid Dies for the Cold-header

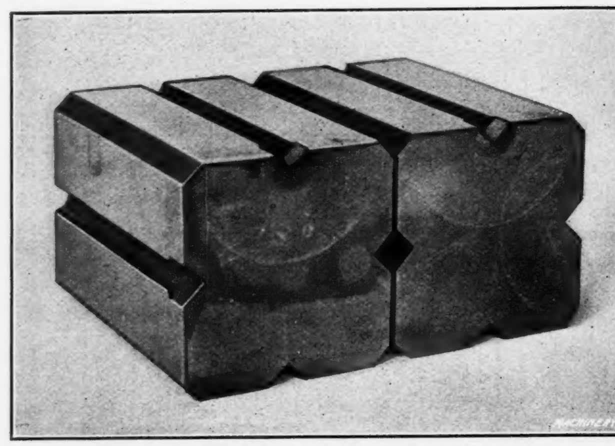

Fig. 29. A Pair of Open Dies for the Cold-header

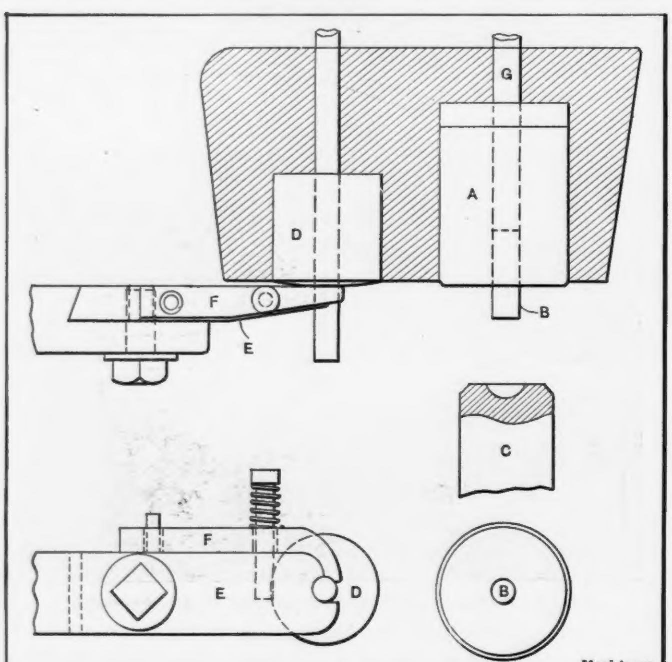

Fig. 30. Section of Cold-header showing Locations of Principal Tools

Tools for cold-heading machines may be roughly divided into two classes—those used in solid-die machines and those used in open-die machines. Whether the tools are for a single- or double-blow machine affects only one extra tool, namely, the upsetting or coning punch. In all other respects the tools are similar. The chief difference between the tools for the solid-die and open-die machines lies in the dies themselves, the punches being the same in both cases. Figs. 28 and 29 illustrate the difference between dies for the solid- and open-die machines. Fig. 28 shows a die and punch for a solid-die machine. These tools are very simple, being merely sections of round stock, the die being made with a hole to agree with the diameter of the wire, and the punch with a cavity of the correct shape for forming the head. In Fig. 29 a pair of open dies, without the punch, is illustrated. In this case the wire is held between the halves of the die, and the cutting off is done by the dies themselves, as was explained in the May installment. Therefore a pair of dies for the open-die machine must be of exactly the same length as the finished rivet under the head. The dies shown in Fig. 29 were made for forming a carriage bolt having a square shoulder under the head. By referring to Fig. 30, a set of tools for a solid-die machine may be seen in place. These consist, in the case of a single-blow machine, of the die *A*, in which the wire blank *B* is held for heading; the punch *C* which shapes the head and is actuated by the ram of the machine; the cut-off die or quill *D*, which is similar to the heading die, having a hole through its length through which the wire is fed against a feed-stop (not shown) the proper distance, and is then cut off by the cut-off blade *E*. The face of the cut-off die is crowned to help the cut-off blade do its work. Mounted on the cut-off blade is a carrier *F* that holds the blank to the cut-off blade so that it may be carried over to the heading die. A backing pin *G* fits in the hole in the heading die and regulates the length of the rivet under the head; it also serves as an ejector after the rivet has been finished. In Fig. 33 may be seen a set of heading tools, with the exception of the cut-off quill. These particular tools were used in making a round-head screw that required two blows to form the head. The die is shown at *A;* the second-operation punch at *B;* the first-operation punch at *C;* the backing pin at *D;* and the cut-off blade without the carrier at *E*. At *F* may be seen the cut-off blank; at *G* the coned blank

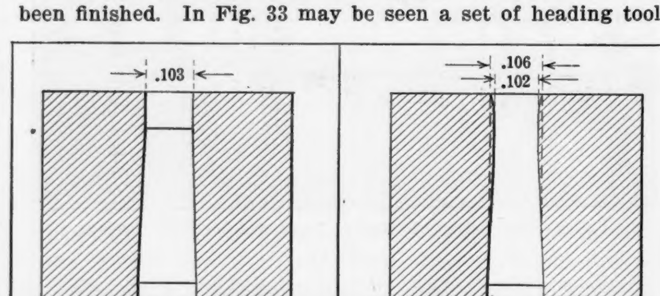

Fig. 31. Section of Solid Die showing Allowances left for Hardening Fig. 32. Section of Solid Die showing Usual Shrinkage in Hardening

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† Chief draftsman, Blake & Johnson Co., Waterbury, Conn.

resulting from the first operation; and at *H* the finished round-head screw. If this same job were to be used in an open-die machine the cut-off blade and the backing pin and die would be eliminated and a pair of open dies substituted.

Making a Solid Die

At first glance, the solid die appears to be simply a round piece of stock with a hole extending through it to receive the wire. There are, nevertheless, many points to be considered in making this die, and without the knowledge of them the tools would never work satisfactorily. The heading dies, punches and cutting-off tools are made from a good grade of tool steel, annealed stock being preferred. The tools are sometimes made of low carbon steel and then carbonized, and at least one large user of heading machines follows this method exclusively, but unless the best of carbonizing and hardening facilities are available it would be inadvisable.

The length and diameter of a heading die are governed by the size of the machine in which the die is to be used. An idea of the proportion of the diameter to the length may be obtained by stating that for handling wire up to 1/8 inch

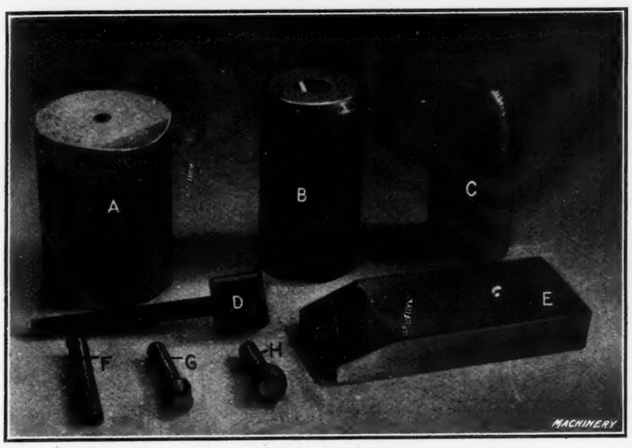


Fig. 33. A Set of Heading Tools and Work from a Double-blow Cold-header

diameter, a die of 7/8 inch diameter by 1 3/8 inch long agrees with good practice, and for handling 1/2 inch wire, the die may be 3 3/8 inches in diameter by 4 1/2 inches in length. These dimensions are not arbitrary, but are, of course, determined by the make and size of the machine in which they are to be used. In Fig. 35 is illustrated a little kink by means of which considerable die-steel may be saved. In this case a backing block is made to replace about one-third the length of the die. The dies themselves may thus be made

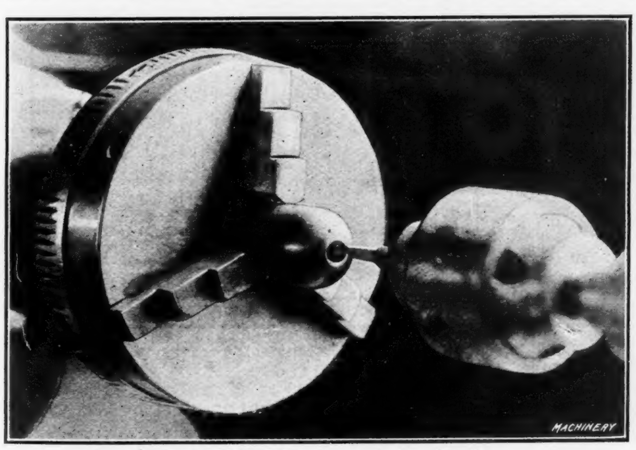


Fig. 34. Reaming out a Coning Punch

correspondingly short, and as this pillar block is used beneath each die, one-third of the steel of each heading die is saved.

Fig. 31 shows, in section, a typical heading die of the solid type, just made and ready for hardening. This die is given with actual dimensions so that the shrinkage allowances may be duly noted. The length of the die is 1 3/8 inch and the diameter 7/8 inch, and it is to be used for heading rivets from 0.105 inch wire. First, a hole a few thousandths under 0.105 inch diameter is drilled through the die. The die is then relieved from the back for a short distance with a No. 33 drill, enlarging this section to 0.113 inch. A tapered reamer which has a taper of about 0.003 inch to the inch is then used to ream out the unrelieved section very nearly to the face of the die. At this point the die is hardened and this operation causes the mouth of the die to "open," leaving it about as shown in Fig. 32. Using emery and oil, the die is then lapped out from the back until the hole measures 0.106 inch diameter, this being 0.001 inch over the diameter

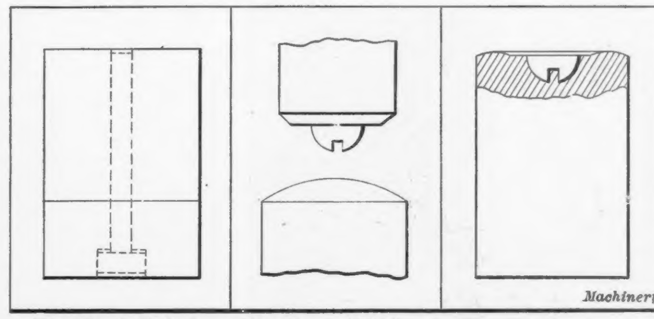


Fig. 35. A Kink for saving Die Stock Fig. 36. A "Hub" and a Punch Blank Fig. 37. Punch after hubbing

of the wire, allowing plenty of play for the working of the stock.

The hardening operation is comparatively simple, the requirements being to have the die, especially the section adjacent to the hole, very hard. A useful kink to be followed in securing the desired hardness is illustrated in Fig. 44. This consists of a funnel shaped bushing which is threaded so that it may be screwed onto the ordinary water faucet. The die is brought to the right heat and held under this conical bushing and the water turned on full force. When

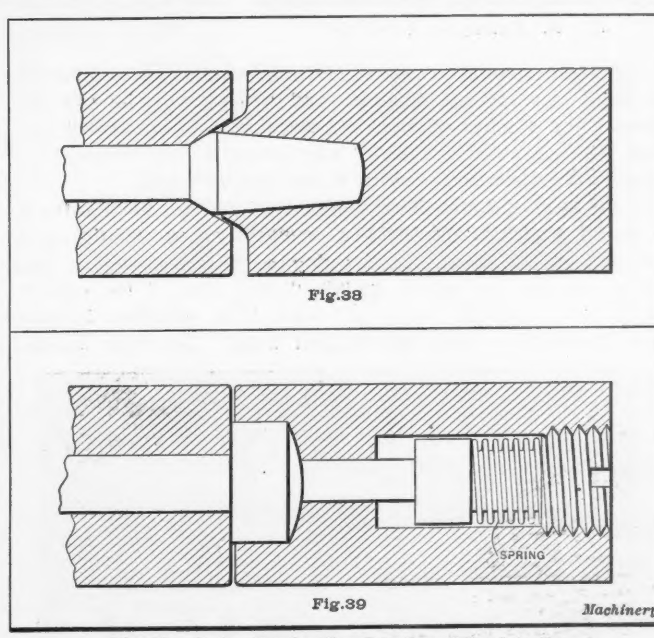


Fig. 38. Coning Punch relieved to force Wire into the Countersunk Head of the Die
Fig. 39. Spring-pin in Punch which facilitates Ejection

the water is turned on, the face of the die and the hole receive a sudden quenching, giving it the extreme hardness that is necessary.

The Punches

Before a punch can be correctly made for any rivet except a "flat-head" a counterbore is necessary to obtain the exact shape of the cavity. In the case of flat-head screws or rivets, the punch consists simply of a length of round steel having a perfectly flat face with chamfered edges. With round or fillistered head blanks, however, the finish punch must contain a cavity of the exact size and shape of the head. In making a punch like that shown in Fig. 33 for a round-head rivet, a reamer of the same semi-spherical shape is necessary. The reamer is turned up in the lathe, leaving a flat shoulder to limit the depth of the cut. The "half-type" reamer is employed, and is relieved only for a short distance behind the cutting edge so that a good bearing is secured while the

punch is being reamed, resulting in a smoothly finished cavity. In hardening these reamers they are drawn to a straw color. In the case of difficult shaped heads, it is often found advisable to hammer a piece of lead into the soft die so that measurements may be taken and checked up with the sample. Weight forms an important feature in determining the amount of metal which goes into the head. In setting up the machine, for instance, the toolmaker will often compare the weights of his rivet and the sample in order to see if the right amount of stock is being used. By cutting off the head close to the shoulder and weighing it, he can determine the amount of stock required, and by balancing the head with an equal weight of wire stock, he can readily determine the distance to which to set the wire feed.

In the case of double-blow machines, in which an upsetting or coning punch is used, there seems to be no definite rule that can be laid down for the shaping of the cavity in the coning punch. As before explained, the idea of the coning punch is to upset the metal and leave it in condition for the final distribution into the finished head. Generally speaking, this intermediate shape is that of a truncated cone, the base of which is very nearly the diameter of the finished head, and the length of which is about two-thirds the amount of wire advanced by the wire feed. The top of the wire is left approximately the same diameter as the blank and slightly rounded. If a very large amount of metal must be put into the head, the angle of the cavity in the coning punch is made as obtuse as possible. It is customary to relieve the coning punch about as shown at C in Fig. 33, the object being to remove all danger of interference with the cut-off blade, because the coning punch strikes the wire blank just as the cutting-off blade releases it; therefore it helps matters to have the cut-off blade relieved as well as the coning punch. When the coning punch is to be used in connection with a countersunk die for flat-head screws, it is relieved about as shown in Fig. 38. By so doing, the wire in the cone is supported and driven down into the countersunk section of the die, instead of being left out at the line of the die face. There are so many governing factors bearing upon the shapes of coning punches that it must be left largely to the judgment of the toolmaker. Punches for fillister head or other deep types of punches where the blanks would be likely to stick are often fitted with spring ejector pins as shown in Fig. 39. Ordinarily the die is the member in which sticking is most prevalent, but when the blank is short and the head is deep sticking will be encountered in the punch.

In the manufacture of very cheap screws, the slot in the head is often formed by the heading punch instead of being sawed. This means that the cavity in the heading punch must have a ridge of steel left standing to drive the metal down for the slot. To cut the cavity to this shape would be practically impossible; therefore the common practice is to

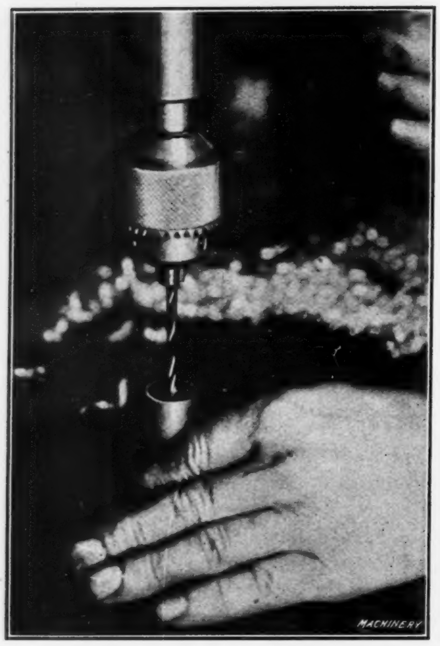


Fig. 40. Drilling out a Solid Die

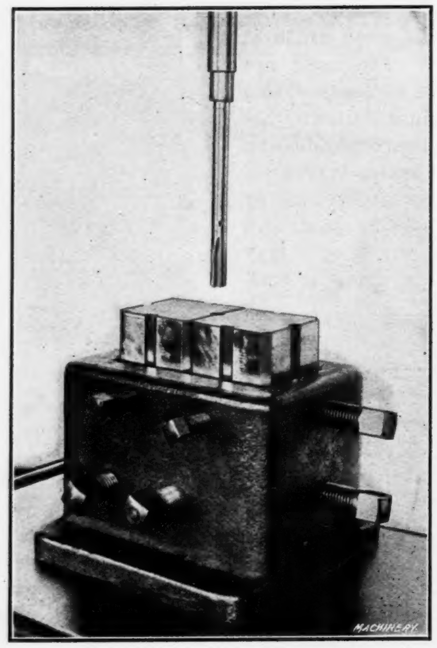


Fig. 41. Reaming a Pair of Open Dies

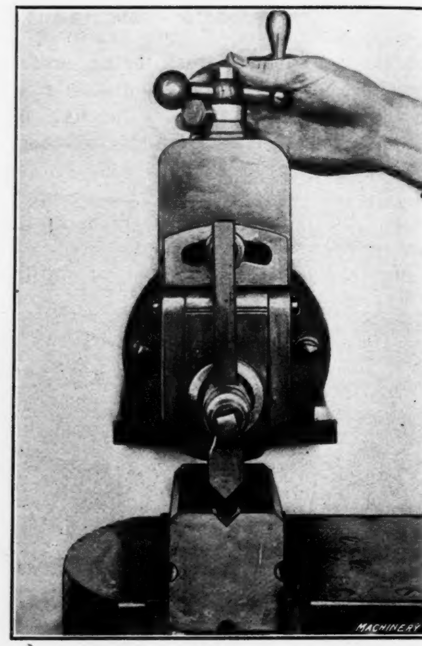


Fig. 42. Shaping Square Section in an Open Die

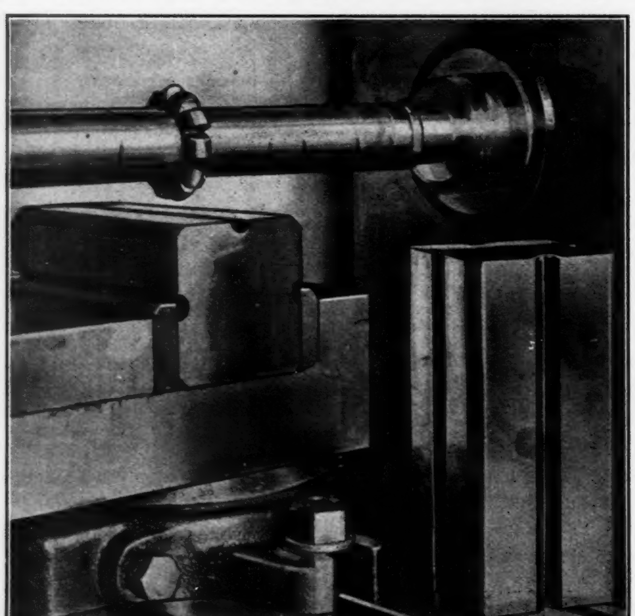


Fig. 43. Milling the Grooves in Open Dies

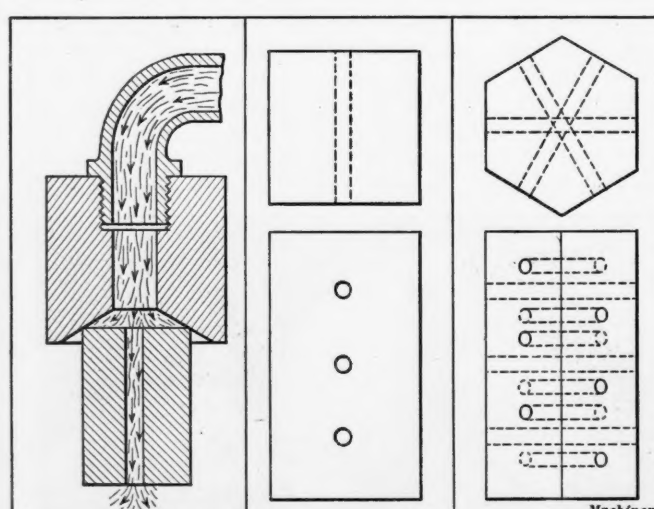


Fig. 44. A Method of hardening Solid Dies
Fig. 45. Multiple Die of Square Type
Fig. 46. Multiple Die of Hexagonal Type

hub the punch. The hub is made by turning up a blank of steel with a face of the same shape as the head of the screw to be produced. A slot is then milled or filed in the center of the head of the hub, after which it is hardened and drawn to a straw temper. Before being hubbed, the face of the heading punch is first convexed so as to leave the highest point at the center, thus providing enough stock to make a well formed cavity. The tendency is for the metal in the punch to sink away from the slot in the hub; therefore by leaving an excess amount of metal at this point, the slot is completely filled when the punch is hubbed. After being hubbed, the punch is faced off, of course, and the sides turned up for hardening. Fig. 36 represents the hub and the punch-blank before hubbing and Fig. 37 shows the hubbed punch before being faced off.

The Cut-off Tools

The cut-off die is simply a section of round stock having a hole extending through it slightly larger in diameter than that of the wire being worked. On small sizes of wire 0.001 inch is enough clearance. The face of this die is crowned slightly so that the cut-off blade which works in conjunction with it may act without binding on any other part of the die face. The cut-off blade is shown at *E* in Fig. 30, from which it will be seen that the end is filed out U-shaped, so as to partly enclose the wire, thus supporting it while the cutting-off operation is taking place. A spring-finger *F* is fitted to the cut-off blade that snaps over the wire when the cut-off blade advances to the cutting and holds the blank so that it can be carried to the heading die. There are different methods of applying the spring-finger or carrier, but a good way is illustrated in Fig. 30. Here the spring pressure is supplied from the spiral spring over the stud near the center, while the pin at the end operates in an enlarged hole in the finger serving merely as a guide to prevent the finger from swiveling. Both cut-off die and blade are hardened and drawn to a straw temper. There is little to be said about the backing pin which is shown at *D* in Fig. 33 except that as it receives the full force of the heading blow, it must be hardened and drawn to a very dark purple.

Tools for Open-die Machines

The only explanation required for tools for the open-die machines is the operations connected with the making of the die halves. These, which are illustrated in Fig. 29, are made by shaping up square sections of tool steel to fit the die-holding block of the header. The halves of the die are left large enough in size to allow for grinding, and down the center of each face is milled a half-round groove of a size slightly less than the diameter of the wire which is to be handled in the header. After the bulk of the stock has been milled out in this manner, as shown in Fig. 43, the halves are clamped in a special holder illustrated in Fig. 41 and a reamer of the proper size is run through the hole, taking half the stock from each die face. Set-screws are provided on the die-holding box to clamp the two halves together and take up end play while this operation is being performed. Each of the four pairs of faces is treated in this manner and, of course, they are marked so that they can be mated readily. The object of having all four faces grooved is simply to make use of the other three sides of the die; thus as soon as one pair of grooves has worn out of round, the dies are simply turned to bring a new pair of faces into use. As was explained in the May installment, the object of chamfering the corners of the die halves is to facilitate the opening of the dies by the spring-finger on the machine. Fig. 42 shows the manner in which the square section of a die for producing a carriage bolt is machined. This square section comes under the head of the bolt and, therefore, must be provided for in the dies. After reaming out the grooves in the die faces the square outline is marked on each of the faces of the die, and the lines scribed for the depth. A starting point is made by chipping a groove at the proper distance from the face of the die, and the rest of the stock is removed by a square shaper tool, thinned down at the face to permit of its starting in the chiseled groove. Each of the faces of the two die halves is similarly treated. As with the solid dies, the open dies are hardened and the faces and sides are ground before being put into use. It is very important that the faces of the dies be properly ground so that they will

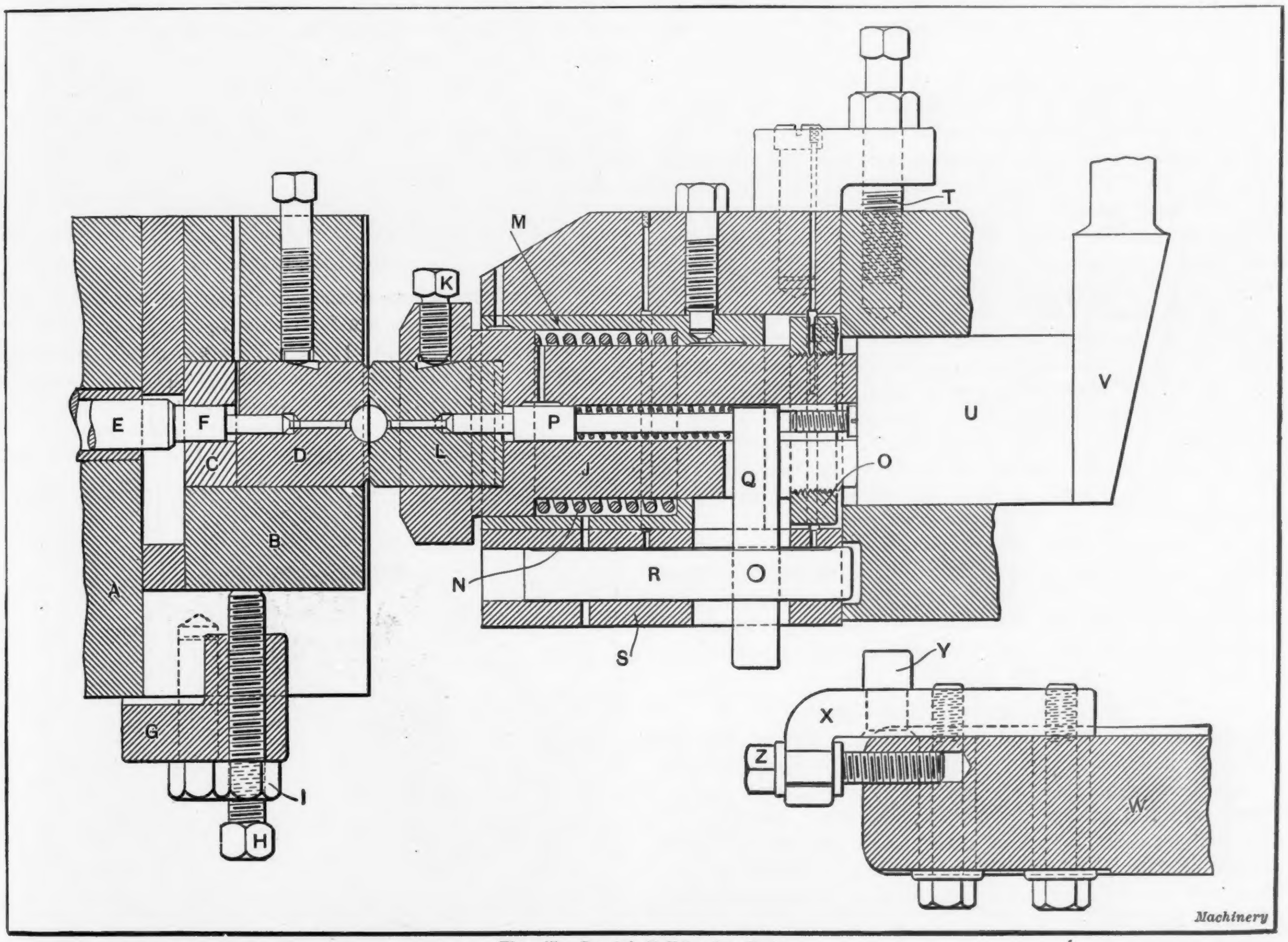


Fig. 47. Special Ball-header Tools

come close together and prevent the headed metal from bulging out in the form of fins on the sides of the work. In grinding the sides of the die halves, the stock taken off permits the faces to come together far enough to flatten the circular opening in which the wire is held. This provides the necessary clearance for gripping the wire.

Multiple solid dies are often made for the sake of economizing in steel. Examples of such dies are shown in Figs. 45 and 46. The die in Fig. 45 has three openings so that after one of them has been worn out of round, the die may be moved along in the special holder necessary to hold a square block and another hole put into use. If the work is such that the die can be made without clearance, the block can then be reversed and the opposite ends of the three holes used. Similarly, in Fig. 46 is a multiple die of hexagonal shape, providing eighteen working openings. As a general rule, however, multiple dies are not used, because of the trouble caused by special die-holders. The plan of reversing the die to use the opposite end of the hole has disadvantages on some work where the heading blows close the hole in so much that the necessary lapping out makes the method more troublesome than beneficial.

Setting up a Plain Job in the Header

In setting up a job in a solid-die header, the first step is to put in the cut-off die and adjust the cut-off blade. The blade is adjusted by snapping the finger over the wire, and while thus held it is clamped in position against the cut-off die. The die is next bolted into its seat and the backing pin adjusted to size the length of the rivet under the head. The finish punch, in the case of a double-blow machine, is then located in the punch-holder. The coning punch is next held in the punch-holder, and, if necessary, it is adjusted to bring its face into line with the finish punch. The finish punch should be set without backing or "shimming" of any kind, but if necessary the coning punch may be shimmed up to agree with it. The stroke is then adjusted so that the punch faces almost touch the die face. After this, the wire feed may be set and the machine is ready to be operated. On every job there is more or less adjusting of the feed, grip and ram movements to obtain the exact results.

In setting up the tools on an open-die machine there is, of course, no cut-off to be taken into consideration other than the proper setting of the die halves, as the cutting is done simultaneously with the movement of the dies. The operations of setting up the punches on the open-die machine are the same as on the solid-die machine.

Special Ball Heading Machinery

The E. J. Manville Machine Co. makes a special type of header adapted for forming ball blanks. The cold-header is an important adjunct to ball making. The principal feature is positive ejection for the ball blanks after heading, because ball headers operate at a very high rate of speed and positive ejection is absolutely necessary. A secondary advantage of this machine lies in its ability to handle positively the short ball blanks.

Fig. 47 shows a vertical longitudinal section taken through the working parts of one of these special ball headers. *A* is the frame or bed of the machine; *B* is the die-block of steel; *C* is a hardened tool-steel backing block for the die *D*; *E* is the backing or knock-out pin which backs up the smaller knock-out pin *F*; *G* is a cast-iron bracket screwed onto the under side of the bed to hold the adjusting screw *H* which raises or adjusts the die-block into the correct position for heading. A lock-nut *I* insures the adjustment. *J* is a tool-steel punch-holder having an enlarged head with a set-screw *K* for holding the punch *L*. The body of this holder is of smaller diameter than the head and is made a sliding fit in the bushing *M*. The holder is normally kept in its forward position under spring tension by means of the coil spring *N*. Two adjusting nuts *O* are on the back end of the holder. *P* is a small hardened tool-steel ejector pin, which is also kept under a spring tension, and is backed up by the bar *Q* that passes through the round rod *R* and is pinned in place. *S* is the punch-slide that carries the punch-holder and other parts shown and is adjusted by the screw *T*. The punch-holder is backed up by a solid block *U* that acts as a buffer as well as a filler between the holder and adjusting wedge *V*. *W* is a bar cast in the bed between the two sides carrying the adjustable bracket *X* that has the stop-pin *Y* and adjusting screw *Z*.

The action of the machine is as follows: The round bar or wire is fed in and cut off in the usual manner, and the cut-off blade carries the blank over to the heading die, but as there is no shank to be pushed into the die, as is the case with a longer blank or rivet, as soon as it is carried over, the gate or ram advances, and also the pin *F*. As pin *P* is under a spring tension the blank is very quickly seized between the two pins, and held in position until the gate has advanced far enough to hold and squeeze the blank into a ball.

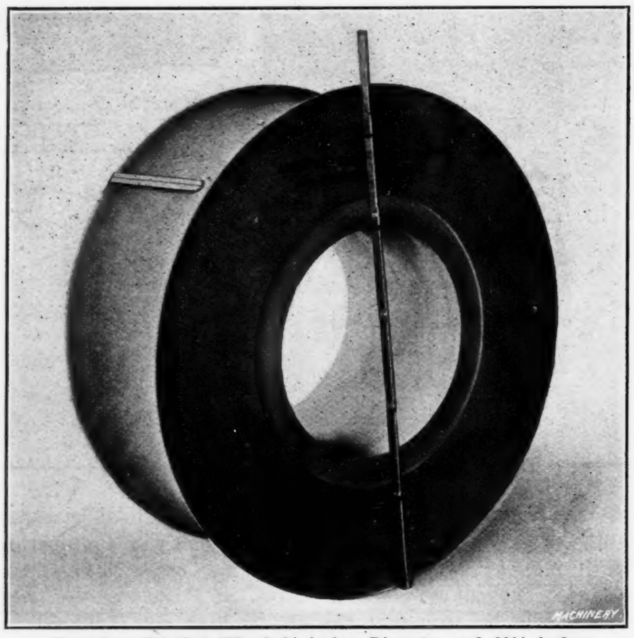
After this the gate returns and when it has reached a certain position the bar or trigger *Q* strikes the pin *P* that acts as a knock-out, and ejects the ball if it clings to the punch; if it clings to the die the other ejector pin *F* ejects it.

It will be noticed that the pins *F* and *P* are not long enough to reach to the ball arc when under the heading pressure; this leaves slight projections on the two sides which can be removed easily, whereas if the pins were even slightly too long there would be flat spots left on the finished balls. The subject of cold-heading is almost inexhaustible, but these three articles have touched upon the most important principles and it is to be hoped that other articles will be contributed showing some specific cold-heading jobs and the tools and methods used in the production.

* * *

LARGE CORUNDUM WHEEL FOR NEEDLE GRINDING

The illustration shows a corundum wheel thirty-four inches diameter and thirteen and one-half inches face, made of corundum by the American Emery Wheel Works, Providence, R. I., for Worral Bros., Sheffield, England. The wheel, which was designed for an automatic textile needle grinding machine, was made by the vitrified process, and is believed by the company to be the largest (combined diameter and



Corundum Vitrified Wheel 34 inches Diameter and 13½ inches Face made for Needle Grinding

thickness) wheel ever made by the vitrified process. The net weight of the wheel is 640 pounds, and wheel makers and users familiar with vitrified wheel manufacture will appreciate the experience and extreme care necessary in handling and finishing such a massive wheel. The final temperature at which the company's vitrified wheels are fired is nearly 3000 degrees F.

* * *

As a part of its campaign to improve agricultural methods, the Pennsylvania R. R. is to distribute among the farmers along its lines 10,000 copies of a book describing the possible uses of concrete on the farm. The distribution of these books will be made through the office of the railroad's agriculturist.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

DEVICE FOR TAPPING BUSHINGS WITH COARSE PITCH THREADS

A large number of brass bushings such as are used in motor car steering rods for controlling the spark timing and inlet and outlet of gas, were to be tapped. Machining these bushings in a lathe was found to be too expensive and not practicable, and as an accurate, quick method was required, a special hand apparatus was designed. This consists of a cast-iron base having three supports as shown in Fig. 1. The one to the left has a hollow shaft and a split collet by means of which the bushing to be tapped is held. The shaft has a dividing flange with three holes which are engaged by a spring-pin for indexing, in order to cut the three threads of the screw. The central support has a cast anti-friction metal nut and carries a large lead-screw of the same pitch as the hole to be tapped. This support has an adjustable cap for taking up wear. The lead-screw is also supported by a third bearing on the right and is fitted with a pilot wheel as shown. The opposite end of the lead-screw has a key and set-screw for holding special taps.

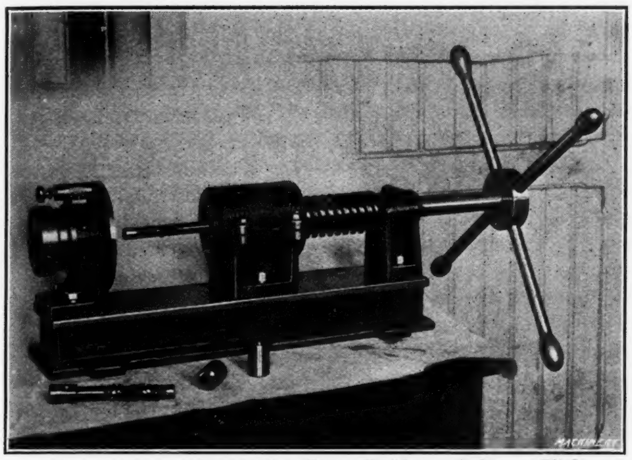


Fig. 1. Fixture for tapping Brass Bushings of Coarse Pitch

When the pilot wheel is turned, the lead-screw moves forward and feeds the tap through the bushing. These taps are an interesting part of the apparatus. Triple-threaded taps did not work satisfactorily as they broke frequently, owing to insufficient room for the dirt or chips. Single-thread taps such as are shown in Fig. 2, were then used, the three threads in the bushing being obtained by indexing the work. These taps gave excellent results, the bushings being tapped quickly and accurately with little wear of the tools.

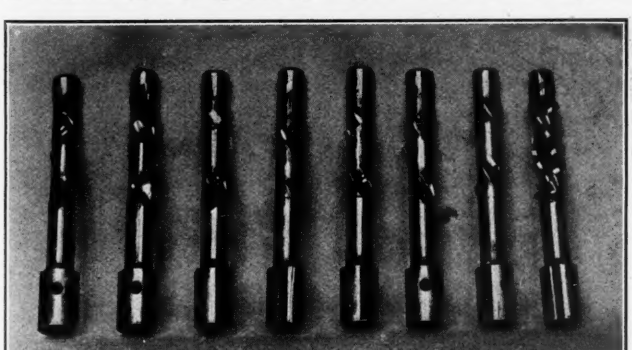


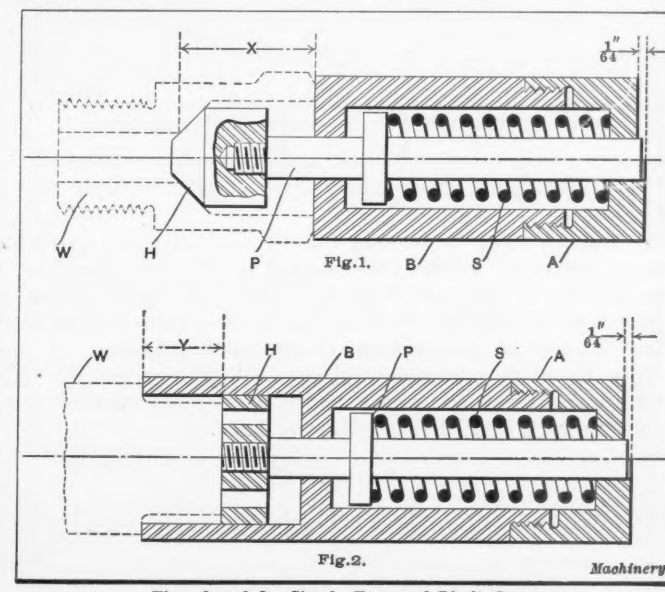
Fig. 2. Set of Eight Taps used in Fixture shown in Fig. 1

The operation of this fixture is as follows: After a roughing tap has been fed through the work, the lead-screw is drawn back; the dividing flange is then moved 1/3 turn and a second cut is taken with the same tap. The work is then indexed again and a third cut taken. The second tap of the set is next inserted and the same operation repeated for the three positions of the dividing flange, and so on for all the other eight taps of the set. The finishing tap has three threads and is used merely to correct slight imperfections left by the previous taps. Two of the finished bushings are shown in front of the fixture in Fig. 1. They are two inches long and 1¼ inch outside diameter. The engaging screw is 1 inch outside diameter and has a 1⅝-inch triple thread of trapezoidal section. The output of this tapping device, when operated by a boy, is thirty pieces per day of ten hours. The lead-screw and taps were threaded in a Pratt & Whitney threading machine.

Turin, Italy. C. BOELLA

INSPECTION ROOM LIMIT GAGES

Two interesting limit gages are illustrated in Figs. 1 and 2. These gages are employed for inspecting parts that are produced at the rate of several thousand per day, and they are said to give perfect satisfaction. Both gages are built along identical lines. They consist essentially of a plunger *P*, plunger head *H*, plunger barrel *B*, spring *S* and barrel cap *A*. The outer face of the cap consists of two planes accurately ground within 1/64 inch of each other, this being the limit within which distances *X* and *Y* are permitted to vary The step or rise of 1/64 inch thus formed on the cap *A* extends across the center of the cap end.



Figs. 1 and 2. Simple Forms of Limit Gages

In Fig. 1 the important dimension is the depth *X* of the bevel seat from the outer edge of the piece *W*. In Fig. 2, *Y* is the important dimension. When *X* and *Y* are right, the outer end of the plunger projects as shown in Figs. 1 and 2. When *X* is too large or *Y* too small, the plunger end is completely inside the cap *A*, and when the reverse is the case the plunger projects beyond the shoulder formed on the face of the cap. The principal advantage of these gages is that work can be carried on with the help of either sight or touch, and thus one sense can be used to relieve the other—a feature that can be fully appreciated only by those who are continually employed in inspection work. These gages were designed by Mr. R. Vessey, superintendent of the Champion Ignition Co., Flint, Mich.

Flint, Mich. M. TERRY

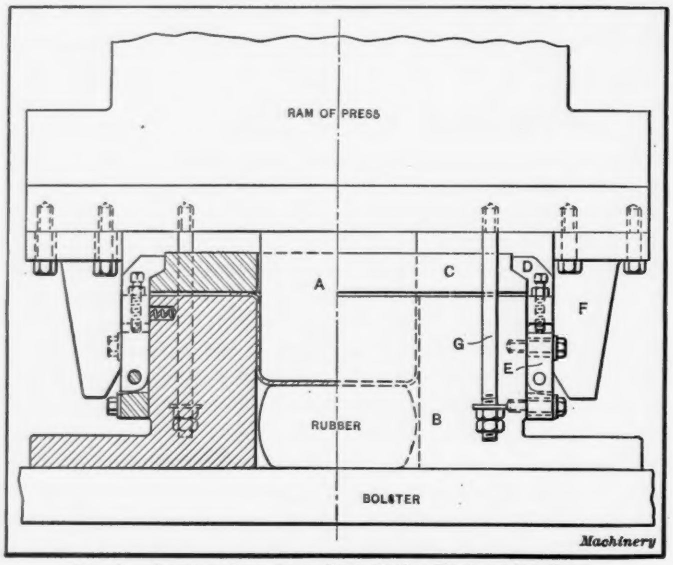
DRAWING IN A SINGLE-ACTING PRESS

We had an order for some steel cups such as would usually be made on a double-acting press. No double-acting press was available, but we did have a long-stroke single-acting press of sufficient capacity to do the job. The die was made as follows:

On the die *B* were bolted some U-shaped pieces *E* which carried the holding hooks *D*. These hooks *D* could be adjusted to any desired degree of tightness by setting down the pieces *E* with the set-screws provided and then clamping

them securely in place. The blank-holder C was suspended on four bolts G, and these bolts were adjusted to the proper length so that the blank-holder C was laid on the blank early in the stroke; then closing lugs F engage the holding hooks D and force them in on the beveled ledge of the blank-holder. The lugs F then slide along the back of hooks D during the remainder of the stroke.

On the up stroke the closing lugs leave the hooks D which are immediately thrown open by springs provided for this purpose, and then the blank-holder C is lifted up by the



Die for drawing Cups in a Long-stroke Single-acting Press

suspension bolts G. The formed piece is loosened in the die by the rubber block or, if necessary, a positive stripper can be provided.

At first we made the closing lugs F solid with the punch-holder, but after several were broken by dirt or other foreign substances getting under the blank, we made a new holder with the lugs bolted on, and now the bolts will usually allow the lugs to give enough to prevent breakage.

This die is more expensive than would be required for a double-acting press, but works nearly as well and enabled us to do the work with the equipment at hand.

W. ALTON

HOLDING DEVICES FOR FIRST-OPERATION WORK

The chucking fixtures shown and described in the article on "Holding Devices for First-operation Work," by Albert A. Dowd, in MACHINERY for November, are very interesting examples of this kind of work, but they appear to me to be expensive, and for the most part would only be justified by

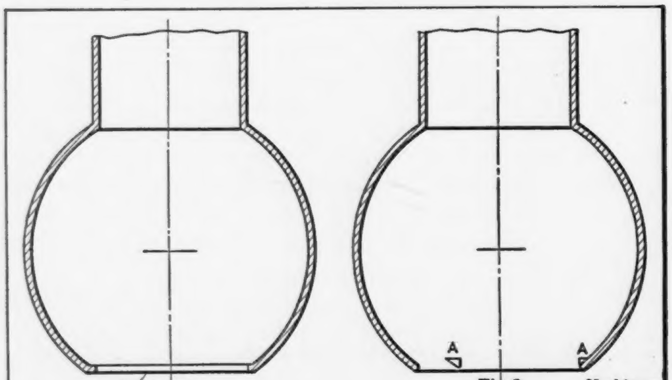


Fig. 1. Ball Joint having Internal Flange to provide Clamping Surface

Fig. 2. Ball Joint with Clamping Lugs to be used if Internal Flange is not permissible

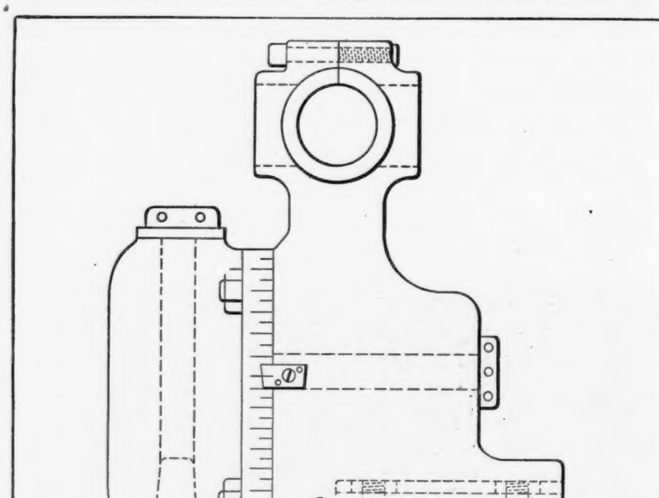
the production of large numbers of the parts for which they were designed. I shall, however, confine my discussion to the fixtures for ball and socket pipe joints shown in Figs. 3, 11 and 12 of the article referred to. Such pieces as this, especially when of large size, as shown in Figs. 11 and 12, are likely to be made in such small quantities that the fixtures should be of the cheapest if they are required at all.

The designer of any piece of machinery should not only be capable of designing mechanism that will perform the functions desired, but should so shape the various parts that they may be readily machined in ordinary machine tools with the least possible outlay for special equipment. In this case I think the designer has failed in just that respect. It would have been better to have made the patterns for both of these joints with an internal flange on the lower end of the ball, as shown in the accompanying illustration Fig. 1, the opening through the flange being the same size as the throat at the other end of the piece. The casting could then be held by a regular three-jawed chuck with the jaws inside, and the bull center could be used for an outboard support as shown in Fig. 3 of Mr. Dowd's article. With the pattern made in this way, either end of the piece could be machined first, and the core would make a smoother opening in the flanged end of the casting. If the face F, Fig. 1, is machined, and a cut taken through the opening, a finished surface is provided for locating the piece for future operations. If the flange in the opening is not permissible, three small lugs A, Fig. 2, could be cast inside the ball; then the first chucking becomes a simple matter of clamping by bolts and straps to the faceplate of either the lathe or boring mill. No special fixtures are required for either method of holding the work.

Springfield, Mass. F. H. BULLARD

SLOTTING ATTACHMENT FOR VERTICAL MILLING ATTACHMENT

The illustration shows a slotting attachment which was designed by the writer for use on a Brown & Sharpe compound vertical spindle milling attachment. Those who are familiar with this type of vertical milling attachment know that there



Slotting Attachment for B. & S. Compound Vertical Spindle Milling Attachment

are two flat surfaces provided with T-slots to which the bracket is fastened which supports the attachment. These two surfaces are located at right angles to each other and only one surface is used to support the attachment, the provision of the two surfaces enabling it to be set up in different positions. The writer did not make use of the bracket in connection with the slotting attachment, although it could be used if desirable.

Referring to the illustration, it will be seen that the slotting attachment consists of a frame A which is bolted to the T-slots of the milling attachment. The slide B fits into the frame A and carries the tool-holder C, in which the tool is secured

by means of a set-screw at the side. Almost any form of shaper tool such as a lip, diamond-point or square-nose tool can be used in this holder. A spring *D* is provided at the back of the holder which allows the tool to drag on returning.

The slide is driven by means of a connecting rod *E* which transmits power from the crank *F*. This crank is mounted in the spindle of the milling attachment by means of a tapered shank, and the crank may be made of any length to give the desired stroke. This slotting attachment can be used in a number of ways and suitable tools can be made for slotting small keyways in gears or pulleys, for use on die work, etc.

Harrisburg, Pa. A. F. Lighthart

SPRING SUPPORTED CANTILEVER

In the December number of Machinery, "How and Why" section, an error occurs in the solution given by William L. Cathcart of a spring supported cantilever. The deflection as arrived at is correct, but the stress *S*, as given, is incorrect. The method pursued would give the maximum stress at the end of the beam, but no stress at all at the support, whereas the two stresses, of course, are exactly opposite to this. The bending moment in a section 15 inches from the support is evidently equal to 500 (20 — 15) = 2500 inch-pounds, this being the moment of all forces to the right of the section. It is not necessary to deal with the reactions at the support. In the solution given the reaction is given as 395 pounds, but to this should be added a couple which equals 500 × 20 — 105 × 10 = 8950 inch-pounds. This is a necessary condition if the forces are to be in equilibrium.

Hartford, Conn. A. E. Larsson

SCREW COMPENSATION FOR SHRINKAGE IN HARDENING

In the December number of Machinery "W. B. T." presents an interesting problem: He wishes to cut a screw to fit the threaded portion of a chuck jaw, the length of which and, consequently, the pitch of the thread, has been diminished by the contraction incident to hardening. In other words, he wishes to cut a thread of slightly less than standard pitch. What may be called the reverse of this problem is familiar to many of us; that is, cutting a thread slightly coarser than standard pitch, to compensate for the shrinkage in subsequent hardening of the threaded piece.

If, for example, a tap is to have 8 threads per inch and we know that the contraction of the steel necessitates cutting the thread 0.12502 inch pitch instead of 0.125 inch, the lathe is geared to cut 0.125 inch pitch and the taper attachment is set to an angle the cosine of which is $\frac{0.125}{0.12502}$. The tailstock is also set over to bring the axis of the work parallel with the taper attachment.

The same method could be applied as readily to the cutting of threads slightly finer than a standard pitch, if the lathe were supplied with gears to cut a little finer than the required pitch. For instance, if 0.197 inch pitch were required, it could be easily obtained if we had gears to cut 0.195 inch pitch. The way in which this result is attained by the writer is to insert in the change gear train compound gears of nearly the same size. Compound gears which are often used have 83 and 84 teeth, respectively, giving a pitch 83/84 of what the lathe would cut if the compound gears were not used. Thus, the 0.200 inch pitch (5 threads per inch) of W. B. T.'s problem would become 83/84 of 0.200 inch or 0.19762 inch. The length of the threaded part of the chuck jaw is not stated, but if it were 2 inches the contraction would reduce the 0.200 inch pitch to 0.19843 inch. Dividing 0.19762 by 0.19843 gives the cosine of 5 degrees 12 minutes, to which angle the taper attachment should be set.

The writer is aware that devices are in use on other tools than the engine lathe for giving a pitch slightly coarser or finer than standard, but has assumed that the thread is to be cut by one who has only the ordinary lathe at his command. It is often possible to obtain the desired pitch without the 83- and 84-tooth gears or their equivalent, if one has a metric lead-screw. For example, to cut a thread of 0.19843 inch pitch, as in the preceding case, gear the lathe for cutting a thread of 5 millimeters pitch (0.19685 inch); then set the taper attachment to 7 degrees 14 minutes, which will give a pitch of 0.19843 inch (0.19685 ÷ 0.19843 = cos 7° 14').

The use of compound gears has the great advantage of wide applicability, as the gears can be used for any pitch. There is a well-known objection to cutting threads with the tailstock set over, as the dog does not drive the work with constant velocity, the tail oscillating in the faceplate slot. If the work is so fine as to make correction necessary, this defect can be overcome by driving with a pair of bevel gears, as is customary in some shops when taper work is to be threaded, and in the relieving of angular cutters.

New London, N. H. Guy H. Gardner

Regarding "W. B. T.'s" problem of decreasing the pitch of a screw, the condition of the piece which the screw is to fit is not quite clearly stated, as that much discussed matter of "pitch" is left open. As I understand the pitch of a screw, it is the length divided by the number of threads in that length, or, in this case, 1 inch divided by 5, which equals 0.2 inch pitch. If this is the case and the pitch has shrunk 1/64 inch, then the number of threads is 1 divided by 0.2 — 1/64, or 5.423 threads per inch. However, since W. B. T. wishes a compensating device and not a definition of the word "pitch," I will say no more about that.

A compensating device to increase the pitch is very simple, if a lathe with a taper attachment is at hand. It is done by setting over the tailstock of the lathe, either way, and setting the taper attachment to cut the screw parallel. This causes the center line of the work to form an angle with the travel of the carriage, the movement of the latter being along the side adjacent to the angle while the work represents the hypothenuse; hence the amount of compensation in any given length will be the difference between the length of the side adjacent and the hypothenuse of the angle.

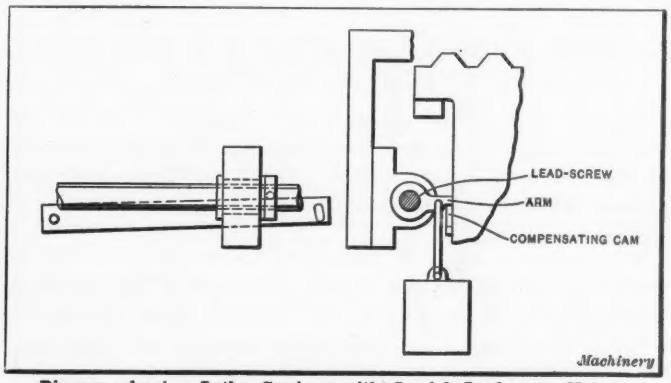


Diagram showing Lathe Carriage with Special Lead-screw Nut to decrease Pitch of Thread being cut

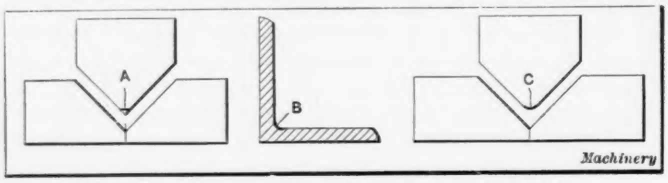
Decreasing the pitch is a more difficult proposition, and where the amount of compensation is known probably the simplest way is to make a special gear or number of gears to cut it. Another way, and a very good one, is to remove the regular nut from the lead-screw and fasten a bracket to the lathe carriage to carry a special nut that can be caused to rotate in the bracket. An arm is fastened to the nut and arranged to bear on the upper surface of a compensating strip or cam fastened to the lathe bed, the arm being held in contact with the cam by means of a weight. (The accompanying illustration shows the arrangement roughly). The compensating strip can be adjusted to give any desired increase or decrease of travel within reasonable limits.

I have never seen this device used for this purpose, but some time ago a similar one was described in some technical paper as a means of correcting inaccuracy in lead-screws, and I think it would answer W. B. T.'s purpose in every way. However, I believe it would be more practical to make the jaws of a grade of steel less liable to variation in hardening, and then correct the inaccuracy due to hardening by lapping on a long screw made of brass or soft steel, as this would give a more uniform contact.

Watervliet, N. Y. D. Tappan

ANGLES OF ANGLE BEAM SHEAR BLADES

I wish to submit an answer to J. D. Y.'s question in reference to the angle of the angle beam shear blades, published in the November number of MACHINERY. Some four years ago we were having a lot of trouble with our shearing machine, due to the point of the upper blade breaking off, as shown at *A*. The problem of overcoming this difficulty was turned over to me. I found that the angle beams we were shearing were of



Original and Improved Types of Angle Beam Shear Blades

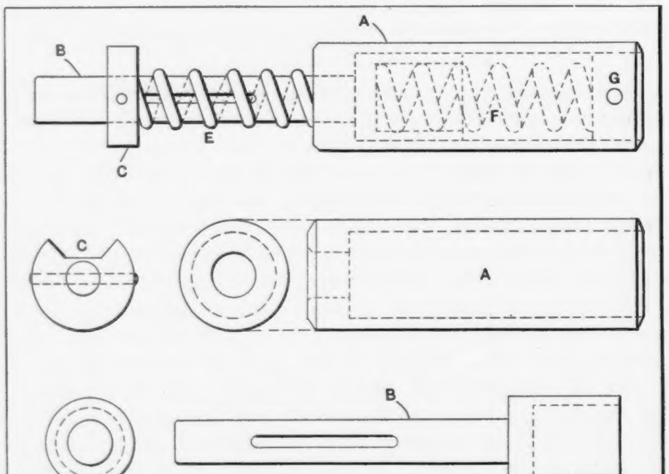
the form shown in cross-section at *B*, with the inside corner slightly rounded. It appeared reasonable to assume that the trouble was due to this rounded corner for in shearing such a beam, all of the pressure would be concentrated on the point of the blade for a short period of time. Acting on this assumption, I made the upper blade of the shear with a round point, as shown at *C*, instead of with a sharp point of the form shown at *A*. After this blade was put in operation, no further difficulty was experienced. In conclusion, it may be stated that the angles of the upper and lower blades should be the same.

Auburn, N. Y. JAMES BURKE

TURRET ARBOR AND EJECTOR FOR GANG CUTTING OPERATIONS

The arbor illustrated herewith was designed for use on the Cleveland automatic screw machine when cutting off collars or washers with a gang cutter. The illustration shows the parts assembled and in detail. This arbor has several advantages.

The hollow shank *A* is gripped in the turret of the screw machine and contains the plunger *B*, which is free to move backward against the coil spring *F* held in place by plug *G*.



Turret Arbor for Gang Cutting-off Operations—The Spring-plunger enters Drilled Hole and Collar C ejects the Cut-off Washers or Collars

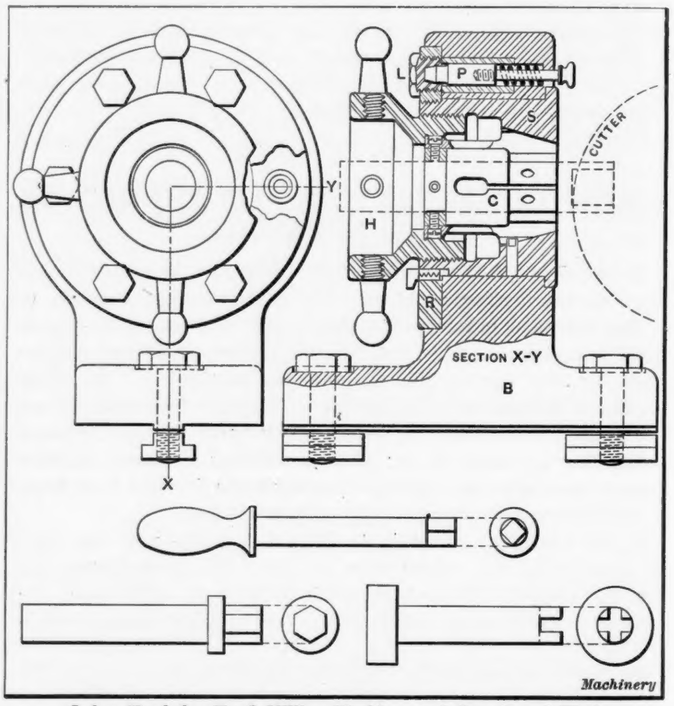
In using this fixture, the plunger *B* enters a hole drilled in the end of the stock, from which the collars are to be cut off by the gang cutter on the cross-slide. In case the cross-slide has traveled its entire distance before the turret has advanced to its limit of movement, the end of plunger *B* will strike the bottom of the hole and will cause a pressure against the coil spring *F*, which allows a sliding movement backward into shank *A*; this has proved to be a valuable advantage. The collar *C* is fitted with a pin for sliding in the slot shown in *B*, and is cut away (see end view) to provide clearance for the gang cutters. This collar acts as an ejector when the turret reverses. During the forward movement the collar recedes so that plunger *B* can hold a number of collars or washers. As soon as the turret has started on its backward movement, the parts are ejected into the work pan by the compressed coil spring *E*.

One great advantage this arbor or fixture has over others used for this purpose is that after the gang cutter has finished cutting the washers or collars from the bar stock, they have already passed over plunger *B* which holds them when the cross-slide moves away from the bar; thus, in case of chips clogging the gang cutter, there is no danger of the washers or collars hanging fast between the cutters and causing trouble.

O. GORDON

INDEX HEAD FOR HAND MILLING MACHINES

A useful index head for hand milling machines used for machining duplicate parts, is shown in the accompanying illustration. This head is made with a hole through the center, so that the parts to be milled can be inserted in the collet from the rear. The work projects through the front just far enough to allow clearance for the cutters. This fixture is especially suitable for milling pieces such as are shown in the



Index Head for Hand Milling Machines and Samples of Work

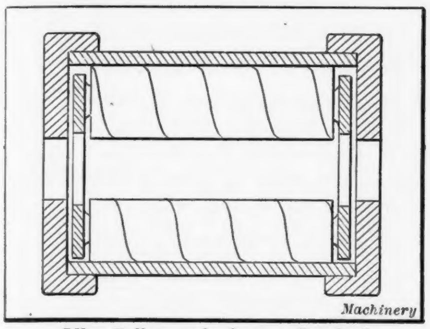
lower part of the illustration, although it can be used as a regular index center in connection with a tailstock center by using a special "dummy collet."

The upright part of the body is made as narrow as possible in order to accommodate short pieces, the heads or shoulders of which might be too large to pass through the collet. The fixture consists of a cast-iron body *B*, in which there is a hardened steel sleeve *S* carrying a spring collet *C*. The latter is equipped with pads and a bushing bored out to suit the part to be milled. The handwheel *H* serves for tightening the collet on the work and also for indexing. The index pin *P* slides in a hardened steel sleeve, and fits in the hexagonal bushings *L*. The latter are carried in an index ring *R*, which is screwed tightly to the sleeve and keyed. The ring is made to index either four or six holes, any holes not in use being plugged with "dummy bushings." The collet has four slots, and on account of its being quite short in proportion to the diameter, it is necessary that the side walls be only about 3/32 inch thick; the slots are also relieved in the middle by openings ½ inch wide, in order that the collet may not be too stiff to be closed easily by the handwheel. The largest stock that the collet will take through the pads is 1⅛ inch diameter.

Oak Park, Ill. R. W. ULLMANN

ROLLER BEARING IDLER PULLEY

We recently received an order for a number of idler pulleys for a 1¼-inch belt. These pulleys were required for use on a group of machines, and aside from specifying that the diameter was to be about 1¼ inch and that they were to be carried on ½-inch shafts, the construction was not specified. The machines on which these idlers were to be used were built with roller or ball bearings and it seemed advisable to follow the same course with the idlers. The method that was finally hit upon is shown in the accompanying illustration. A standard Hyatt roller bearing was selected with a diameter over the sleeve of 1 3/16 inch, which was close enough for the required purpose. Two caps were turned to fit over the sleeve of the bearing, 1 7/16-inch bar stock being used for this purpose. The caps were machined to make them a press fit on the sleeve. By referring to the illustration it will be evident that these caps serve the double purpose of forming flanges for the pulley and heads for enclosing the cage of the roller bearing. The idler pulleys produced in this way were quite accurate and of good appearance; they were practically frictionless and cost less than turned pulleys with bronze bushings.

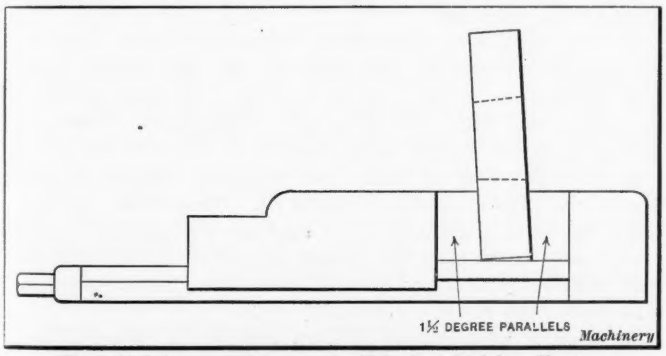


Idler Pulley made from a Standard Hyatt Roller Bearing

Middletown, N. Y. DONALD A. HAMPSON

MACHINING CLEARANCE IN DIES

On page 305 of the engineering edition of MACHINERY for December, A. J. Brickner shows a method of holding dies in the shaper while machining the clearance, by loosening up the shaper apron and tipping it forward. The accompanying illustration shows still another method. The die to be machined is held in the shaper vise by two 1½-degree parallels which hold the die in such a position that the desired angle of clearance is readily machined. These parallels, besides being inexpensive, greatly facilitate work of this kind, and should be a part of every tool-room equipment.



Die held between 1½-Degree Parallels for obtaining Clearance

Waterbury, Conn. CHARLES DOESCHER

BELTS IN COLD WEATHER

In the December number of MACHINERY the following note appeared:

> It has been found by experiments that the difference in power that can be transmitted by the same belt in damp and dry weather may vary as much as 50 per cent, especially if the drive is a vertical one; that is, if in general the pulleys are placed in an unfavorable position.

The writer can imagine no position so unfavorable to pulleys that a difference as great as 50 per cent is possible with belts that are correctly cared for, unless the pulleys are operated out in the open where they might become coated with ice or be subjected to rain or snow. It is true that an excess of snow, ice, or other slippery materials will greatly affect the transmitting capacity of a pulley, regardless of belt treatment, but the mere rise and fall of temperature in a dry or even in a wet atmosphere should have no effect whatsoever. In fact, belts are now waterproofed to such an extent that actual immersion in water for short periods, as in floods, has no appreciable effect on the pliability and pulling power of the belt. A belt that has not been made sufficiently pliable, that has not been waterproofed, and that has absorbed considerable moisture will naturally harden in cold winter weather. And a hard, stiff belt, of course, cannot pull as great a load as when it is pliable. Hardness and stiffness, however, are rapidly going out of date. N. G. NEAR

SPHERICAL BORING-BAR

In the following article is presented a design for a spherical boring-bar for use on a horizontal boring mill. I recently designed this bar and used it successfully in boring a housing for a flexible automobile jackshaft. The housing was first bored straight, forming a cylindrical bore of diameter *D* as shown in Fig. 1. The sides of the work were then faced off to make the total thickness *T*. After these preliminary operations had been completed, the spherical boring-bar was brought into action to machine the inside of the housing to the desired spherical form.

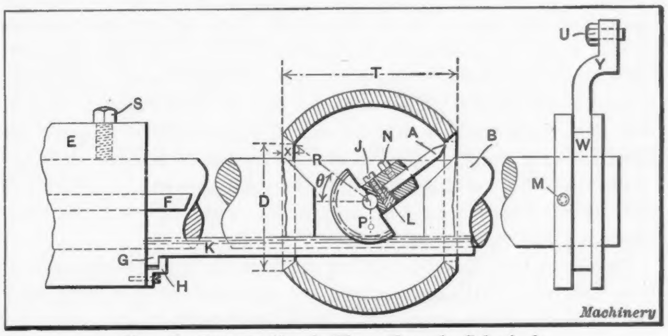


Fig. 1. Cross-sectional View through Spherical Boring-bar and Work

The design of the boring-bar will be readily understood by referring to the accompanying illustration, where it will be seen that the cutter *A* is pivoted in the bar *B*. The bar is keyed to the driving sleeve *E* by means of a feather key *F*. A second key *K* is secured to the driving sleeve; this key has rack teeth cut in it which mesh with a segment gear *P* secured to the lower side of the cutter. The periphery of this segment is of sufficient length to rotate the cutter through the desired angle. The key *K* with the rack teeth cut in it is held to the bar by means of fillister head screws working in slots. When the bar is used for boring cylindrical holes, the cap-screw *S* is used to secure the bar to the sleeve. The action is then the same as that of an ordinary boring-bar.

It will be seen that a grooved collar *W* is provided at the right-hand end of the bar, to which it is held by means of a taper pin *M*; this pin is removed when the bar is engaged in boring cylindrical holes, so that it can be fed through the collar. When used for spherical boring, lateral travel of the bar is prevented by means of the yoke *Y* which is secured to the frame of the machine by means of a stud *U*. The feed of the tool for spherical boring is obtained by the usual bar-feed which moves the sleeve *E* and key *K* along the bar, thereby imparting a uniform feed to the tool by means of the rack and segment gear. It will be seen in Fig. 2 that the key *K* is provided with a lug *G*, over which the keeper *H* is fitted; this prevents the slipping of the key and returns

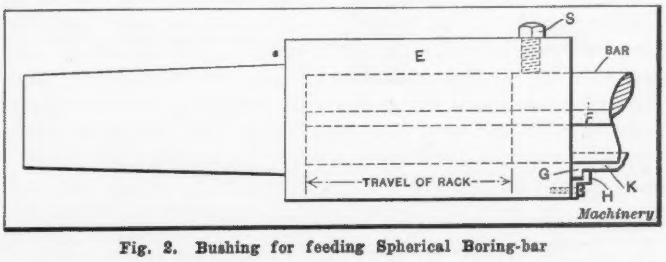


Fig. 2. Bushing for feeding Spherical Boring-bar

the tool to the original position ready for starting a second cut.

In setting up the tool it is necessary to remove the taper pin *M* and tighten the set-screw *S*. The bar may then be withdrawn a sufficient distance to the left to operate the gib-screw *J* and the set-screw *N* in order to obtain the desired setting of the tool. A fine adjustment is obtained by means of the taper gib *L*. Before starting the spherical bore, care should be taken to bring the pin upon which the tool is pivoted to a position exactly central between the two faces of the work or a distance $\frac{T}{2}$ from each end. The diameter D of the preliminary bore should be $2R \sin \theta$. The distance X on the work is $\frac{T}{2} - R \cos \theta$. Where a boring-bar of this kind is to be used on standard work, it is generally advisable to have a separate tool for the spherical boring, as the cutting point of the tool used for this work must have a greater radius than the radius of the cutting point of a tool used for cylindrical boring.

Denver, Col. STANLEY EDWARDS

A PLEA FOR BEVELED EDGES

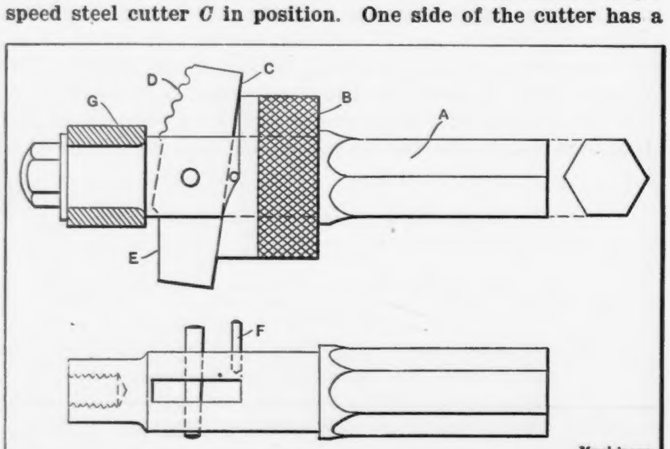
With the advent of modern grinding methods, a practice has developed that is to be deplored. The writer has noticed of late years, that many new machine tools have finished corners ground to a razor edge. A new dividing head (the product of a Cincinnati firm) was so bad in this respect that it was necessary to "break" the sharp edges before it could be handled with safety. One is almost forced to believe that the workmen who build such tools use steel gloves. It would be well if all tools, jigs and appliances were given a uniform curve on their finished lines.

The Brown & Sharpe milling machine is a good example of this practice. All sharp edges are rounded with a 1/16 inch radius tool. This takes little time, and permits the operator to handle the machine with much greater freedom. Let us not forget that the machine tool that is a success must be built for the operator's convenience.

Lafayette, Ind. WILLIAM H. ADDIS

TOOL FOR FACING HUBS

A tool for facing hubs or bosses on castings is shown by the accompanying illustration. As will readily be seen this tool is a roughing and finishing tool combined. The shank or body *A* has a knurled collar *B* which holds a high-speed steel cutter *C* in position. One side of the cutter has a



Combined Roughing and Finishing Tool for facing Bosses or Hubs

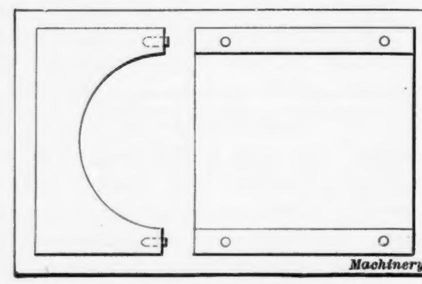
serrated or scalloped edge as at *D*. This rough edge is set at right angles to the tool shank by turning collar *B* half a revolution from the position shown. The idea of the teeth is to rip or tear through the scale. After the scale is removed, the collar is turned to locate the smooth finishing edge of the cutter in position, as indicated by the illustration.

The pin *F* acts as a stop for the collar and, at the same time, holds the collar against a shoulder on *A*. Roller *G* acts as a pilot for the tool. It is free to rotate and can be exchanged for other sizes. This tool has a hexagonal shank which fits the jaws of the drill chuck and prevents slipping. The roughing and finishing edges of the cutter should be faced off in the lathe before hardening, the shank *A* being used as an arbor and collar *B* for holding the cutter in the proper position. The cutter, after being faced, is given the proper clearance. This tool is easily made and is effective, the teeth ripping their way through the scale and leaving clean iron for the finishing side.

B. J. F.

ADJUSTING BEARING BRASSES

It is the practice of some engine builders to leave a space between the brasses of connecting-rod ends, so that wear may be taken up without dismantling the bearings. Usually a piece of leather is put in the space to exert a more or less elastic pressure on the brasses, as well as help to retain the oil; but the first time the rod gets hot, the usefulness of the leather is gone and the joint is generally left open.



Method of adjusting Bearing Brasses

In the writer's experience, brasses thus fitted do not give such good service as when bolted close together. They are likely to cling to the pin at each reversal of stroke; and the play which should take place between the brass and the pin takes place between the brass and the rod, thus interfering with lubrication. Then, in the event of accidental heating, the edges of the brass close on the pin, causing serious damage to the bearing surfaces and invariably requiring the brasses to be removed and eased at the side.

The writer recently tried a little "dodge" on a pair of cross-head brasses which supplied the advantage of the solidly bolted joints and yet allowed wear to be taken up without dismantling the end.

The accompanying illustration shows the device. It consists simply in drilling four holes in the face of one of the half brasses, as shown, and driving in brass pins, which in this case are a little over 3/16 inch in diameter. These pins should be driven to the bottom of the holes. The projecting ends are then filed off until they allow the halves to come together to give a suitable working fit. When wear has to be taken up—if it is attended to in time, as it ought to be—it is found that these pins will crush or imbed in the opposite face sufficiently to allow of this, while the pressure required still leaves the brasses practically solid.

In making adjustments of such brasses as these, it is a custom that is successfully followed both with land and marine engines, to jerk the rod sideways, back and forth, using force according to the size of the engine. This method merely insures that you have not tightened them up too much, which, after all, is perhaps as important as anything.

Christchurch, New Zealand. JOHN PEDDIE

SHRINK VS. PRESSED FITS

In reply to the inquiry by "J. B. F." in the December number, relative to the merits of a pressed or a shrink fit, I favor the shrink fit for the following reasons:

In a large number of shops there are not yet facilities for pressing the machined ring on the shaft (see illustration in December number) other than the sledge hammer, and if the small end of the ring is to be placed last on the shaft there is a possibility of bruising the ring, if it is put on tight enough to hold. In making a pressed fit the average mechanic will file the shaft, cutting off the tops of the ridges left by the tool, and often filing the fit out of parallel, thereby weakening it. The bore of the ring cannot be filed, and it would be considered poor practice to grind or ream the bore as it would lessen, to some extent, the gripping power of the ring.

When the ring is pressed on, the ridges in the bore left by the tool become flattened and are sometimes sheared. To overcome the cutting of the metals, a foreign substance such as oil, paint, white lead, etc., is placed on the surface of the fit, which, in a measure, prevents the metal-to-metal contact. Scoring also takes place sometimes as the shaft is forced through the ring. If the small end of the ring is placed first on the shaft, there is a possibility of its becoming enlarged due to the pressure necessary to hold the ring securely, or ofttimes to the shock produced by the sledge, and sometimes by the cutting, scoring or balling up of the sheared tops of the ridges.

In regard to the molecular arrangement, the molecules adjacent to the fit become compressed or under a strain that is not uniformly distributed. If the ring is subject to shocks, as in the case of gears, the gradual realignment of the molecules will, in time, loosen the holding power of the ring.

In shrink fits it is not necessary to file the fit on the shaft or to ream or grind the bore of the ring, thereby leaving the tool ridges on both the ring and the shaft. When the ring is heated for shrinking, these ridges will clear each other when the parts are being assembled, and, upon cooling, they will, in many places, curl and interlock with each other, insuring a more permanent grip. Again, in shrink fits, it is not necessary to interpose any foreign substance, thereby obtaining a metal-to-metal contact. When the ring is hot it gives the molecules a chance to rearrange themselves, and the strain induced by the pressure upon the cooling of the ring is uniformly distributed.

Anyone having experience with shrink fits that have "stuck" fast knows that it is more trouble to get them loose than with a pressed fit, and, in many cases, the former requires drilling or boring. The only objection to the shrink fit is the discoloration of the parts due to the heat, but if the shrunk ring has to be further machined, this will not be a serious objection. Shrink fits are more easily put together than press fits, and generally a helper is not needed.

Dallas, Tex. SIDNEY HETHERINGTON

In the December number of MACHINERY, J. B. F. inquires about the relative merits of shrink and pressed fits. Assuming that the conditions are alike in both cases, there is this in favor of the shrink fit: The shrink fit can be successfully assembled without lubrication, whereas the press fit can not, and it is reasonable to assume that surfaces will move upon each other more easily with lubrication than without. Of course a hardening lubricant, such as white lead, could be used, but even with this I doubt very much if the adhesion would be as great as with no lubricant at all.

Again, suppose the surfaces were not perfectly smooth, then the irregularities, with a shrink fit, would become imbedded in each other with a doweling effect which could not be obtained with a press fit. I had this proved to my satisfaction about ten years ago by making a mistake in boring out a ring about 10 inches inside diameter, 12 inches outside diameter and 1 inch thick, to be shrunk on the outside of the base of a large valve to increase its diameter. Before heating the ring I happened to try it on the base of the valve and found that it slipped on readily. I mixed some sand and white lead and spread a liberal coat on the valve base, heated up the ring and shrunk it in place, after which the valve was chucked in the lathe and a cut fully one-fourth inch deep taken off the outside of the ring. To the best of my knowledge that fit is doing satisfactory service yet.

Where the quality of the steel is such that it is likely to be impaired by heating, that is, steel that has to be tempered to bring it up to certain physical requirements, care should be taken not to heat the piece above, or up to, the temperature at which it was drawn in its treatment; if this were done then the press fit would excel the shrink fit. This may possibly need some explanation. Suppose the piece of steel illustrated on page 313 of the engineering edition of MACHINERY for December were a good quality of carbon tool steel, and were heated to about 1200 degrees F., hardened in oil, and then drawn to 1100 degrees, which should give the steel its maximum strength and still leave it soft enough to machine. Such a piece would require more pressure to seat under a press than one made of soft machine steel, provided the allowance was the same in both cases.

Where a pyrometer is available it is not at all difficult to avoid overheating the steel, as very little steel whose qualities depend on its treatment is drawn below 700 degrees, and 600 degrees is ample for any shrink fit. If a suitable furnace and pyrometer is not available, the temperature can be obtained accurately enough for all practical purposes by measurement derived from the following formula: Taking the coefficient of linear expansion of tempered steel as 0.000007, D as the diameter of the piece before heating, S as the shrinkage allowance, C as the clearance, T as the difference in temperature, then

$$\frac{(S + C)}{0.000007\ (D - S)} = T$$

or

$$\frac{(0.002 + 0.003)}{0.000007 \times (1.9375 - 0.002)} = 366$$

degrees. If the piece to be shrunk is bored to 1.9355 at a temperature of 60 degrees (allowing 0.002 inch shrinkage) we have 366 + 60 as the heat necessary to increase the bore 0.005 inch, and when the bore measures 1.9405 inch we know that the piece is at 426 degrees approximately. For untempered steel and cast iron, a coefficient of 0.000006 should be used.

With larger diameters where there is likely to be a force exerted tending to push the piece off its seat, interlocking shoulders can frequently be used. In a piece 24 inches in diameter an expansion of 0.1 inch can readily be obtained, which would allow shoulders of 0.05 inch to be used. Of course it would be impossible to assemble such fits by means of a press.

Watervliet, N. Y. D. TAPPAN

CONSTRUCTION OF MOLDS FOR DIE CASTING

The following description of a die-casting mold is intended to give those not familiar with die casting, a general idea of the constructional features of such a mold; the writer has also given some practical pointers on the making of these molds which should be of value to any diemaker thinking of entering the die-casting business. The accompanying illustrations show a mold for a ball-and-socket joint. The mold for a die casting usually consists of the bottom die, top die, the base casting for supporting the dies, and the mechanism for operating the ejector-pins and core-pins. The surface A (Fig. 1) between the bottom and top dies represents the dividing line of the mold, the two dies being separated at this point when the casting is formed and is ready to be removed from the mold. The bottom die is located in the proper position by four dowel pins B (Fig. 2) fastened in the top die. Aside from these main parts of the mold, there is the core-pin plate C, Fig. 1, and the ejector-pin plate D; the former, which is shown to the left in Fig. 2, consists of two parts, E and F, which are fastened together by screws. This plate supports the core-pins G, which form the holes in the casting, and, in some cases, sections of the core which are under cut, as it is not always possible to design the cores in the die so as to provide clearance in all directions. Core-pins intended for clearance holes in the casting, are made not less than 0.003 inch larger than the regular clearance size. When core-pins are ¼ inch and larger in diameter, spotted holes are preferable to oil grooves, because the lubricant stays in the spotted holes, whereas it has a free movement through an oil groove.

When a large number of core-pins is necessary to form the different holes in a casting, it is usually a good plan to give a number of them (and sometimes all of them) a "floating fit" in the core-pin holder E, Fig. 2. Otherwise, if the core-pins are driven in and headed or riveted over on the under side of plate E, they are sometimes forced out of alignment by being headed a little more on one side than the other, or perhaps the core-pin hole in E is not in perfect alignment with the core-pin hole in the top die, through which the pins pass when operating the mold. Both cases would tend to retard the movement of the core-pins and increase the wear on one side or the other, and in the constant operation of the mold, the

pins might be worn rough or work stiffly, thus making it necessary to have the die repaired. If the pins are given a floating fit in the holder, however, by making the core-pin holes in plate *E* from 0.001 to 0.002 inch larger than the diameter of the core-pin, the difficulties stated would be overcome.

For core-pins ¼ inch in diameter and larger, it is customary to have a shoulder of from 0.003 to 0.005 inch, so located that it will extend 1/64 inch into the casting. The reason for having this shoulder is that when withdrawing the core-pins from the finished casting, that part of the core-pin which forms the hole, being from 0.003 to 0.005 inch smaller than the core-pin hole in the top die, will have no bearing except in the hole formed in the finished casting. This clearance between the top die and core-pins reduces the liability of the core-pins being roughed up at this vital point, by the dirt that collects around them and is likely to be drawn into the holes when they are withdrawn below the working surface of the top die, preparatory to ejecting the finished casting.

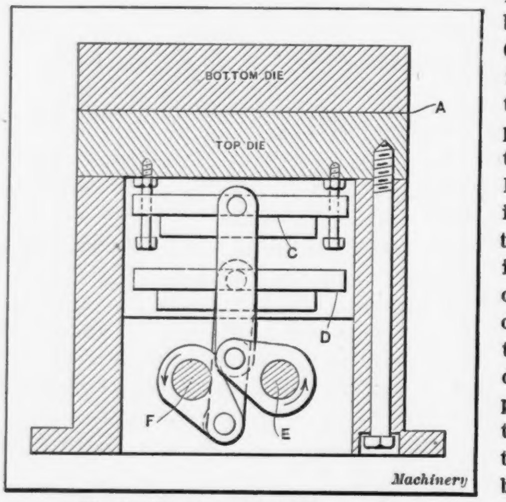


Fig. 1. Diagrammatical View showing Arrangement of Mold for Die Casting

The core-pins are withdrawn by an upward movement of the lever attached to shaft *E*, Fig. 1, and the shaft *F* operates the ejector-pins. The movement of the core-pin plate *C* is controlled by a positive stop consisting of four screws and check-nuts, as shown in the illustration. The length of this movement is governed usually by the thickness of the casting, plus the distance the core-pins enter the bottom die; but in all cases the pins must be withdrawn sufficiently to be entirely removed from the casting. The distance between the core-pin plate and the ejector-pin plate is governed entirely by the length of movement required to withdraw the core-pins, plus the distance necessary for ejector-pins of sufficient length to lift the completed casting clear of the die. The core-pins have a downward movement, whereas the ejector-pins move upward, but both operating levers work in an upward direction. The core-pin plate is usually located next to the top die, and the core-pins should pass through the top die (in the proper location to form the required holes in the casting) and into the bottom die about ¼ inch.

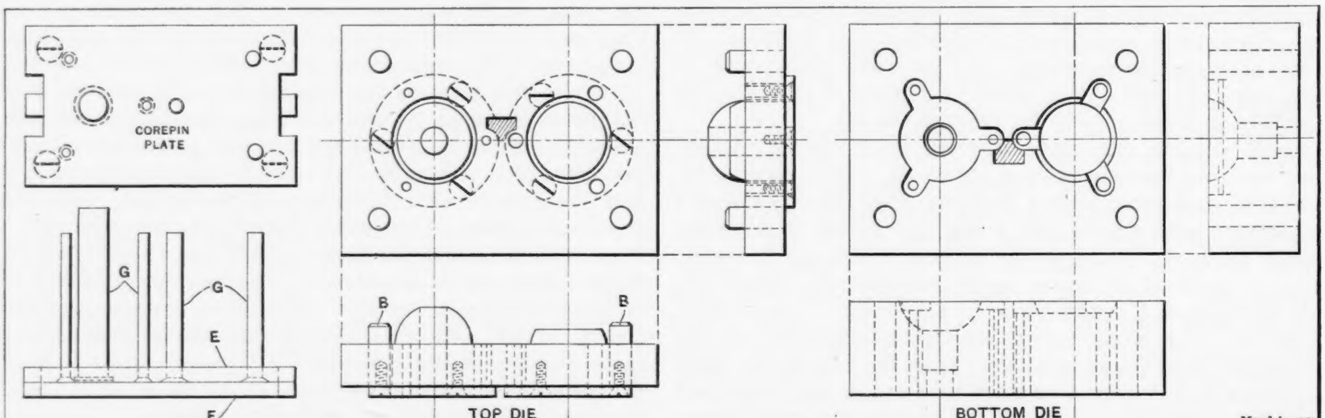


Fig. 2. Core-pin Plate, Top Die and Bottom Die for Die-casting Mold

The ejector-pin plate *D*, Fig. 1, is placed under the core-pin plate and it is guided by the ejector-pins which pass through the top die. These pins are prevented from coming below the surface of the top die by means of four screws and check nuts, similar to the arrangement shown for the core-pin plate *C*. The ejector-pins usually are fastened rigidly to the plate and are not given a floating fit, as the core-pins are. The ejector-pins, as the name implies, are used only for ejecting the finished casting from the top die after the mold has been separated and the cores withdrawn. The ejector-pins, when in their proper location, should be about 0.001 to 0.002 inch above the working surface of the top die, if the casting is not to be finished, and if the casting is to be finished, they should be about the same distance below the surface. The location of the ejector-pins relative to the casting varies in different dies, and depends upon the form of the casting.

The sprue cutter is used to cut off the sprue in the bottom die after the metal has been forced in, thus leaving the casting free and clear in the die. In Fig. 2 the sprue cutter hole is represented by the cross-sectioned part. It passes from the under side of the base, through clearance holes in the core-pin and ejector-pin plates, and then through the top die (where it should be a perfect sliding fit) into the bottom die. The latter should also be perfectly fitted to the sprue cutter for about ⅛ inch below the cutting edge; beyond this point the hole is tapered for clearance. In operating the mold, the sprue cutter is entered into the top die until it is flush with the working surface, and the metal is forced through the sprue hole into the bottom die; then the sprue cutter is forced through the bottom die, cutting off the sprue, which passes out through the tapered sprue hole in the bottom die, thus leaving the casting in the mold free to be ejected when the mold is separated.

Union Hill, N. J. G. I. JOHNSON

PROVING MULTIPLICATION AND DIVISION CALCULATIONS

The following is a very simple method of proving multiplication and division calculations which has proved extremely valuable to me in the course of my work, and should be equally so to readers of MACHINERY who have accurate figuring to do.

For multiplication, proceed as follows: First add the figures of the multiplicand, and if the sum is more than one figure, add again as many times as necessary to reduce the sum to one figure. Next, treat the multiplier and result separately in the same manner. Now multiply the two figures representing the multiplicand and multiplier, and reduce the result to one figure. If the calculation is correct, this figure and that representing the result of the calculation will be the same.

For division, find the sums separately each in one figure, of the divisor, dividend, quotient, and remainder if any. Next multiply the sums of the divisor and quotient, reducing the result to one figure. Now add the remainder, if any, to this result, and reduce the sum to one figure. If the division is correct, this figure will be the same as the one representing the dividend.

While at first sight this method may seem a trifle long and complicated, it is all mental work, and therefore can be done very quickly, which a trial will soon prove.

Montreal, Canada. OSCAR W. MIESS

SPIRAL PERFORATING

I have read a number of articles in MACHINERY describing methods of perforating, but they all pertain to producing holes in straight lines. We recently had to perforate a number of shells of the type shown in Fig. 1 which have four holes pierced on a spiral at four different places on the shell. After trying various methods, the die illustrated in Fig. 2 was finally designed and proved very satisfactory for handling the work. It will be seen that the tool consists of a die-holder *A*, which is carried by the die bed *B*. This die-holder is counterbored to receive the mandrel *C* and cam *D*, which controls the movement of the shell to obtain the desired location for the holes. An index ratchet *E* is keyed to the left-hand end of the mandrel and held in position by a nut *F* which holds it against the die bed. This ratchet is operated by a pawl carried by the ram of the press. In order to take up any backlash and secure accurate indexing, a spring pin *G* is provided. This pin enters counterbored holes in the ratchet,

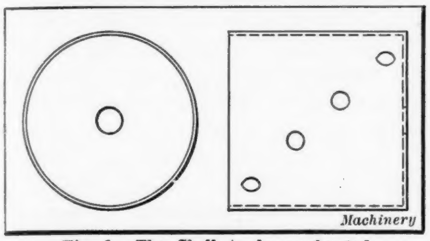


Fig. 1. The Shell to be perforated

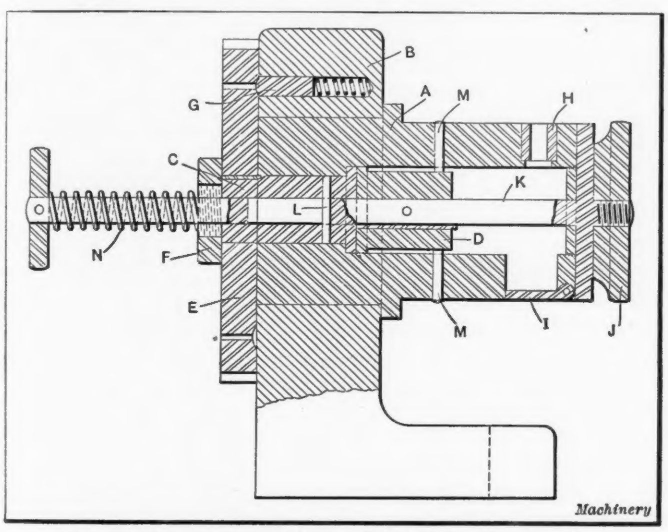


Fig. 2. Type of Die used for the Spiral Perforating Operation

which are properly spaced to locate the holes in the desired positions in the shell; when the ratchet is moved on to the next station, the pin is forced back into the die bed and then enters the next hole in the ratchet.

The piercing die *H* is driven into the die-holder and the piercings are held inside the drum until all of the holes have been punched, by means of a trap door *I*. The shell is held in

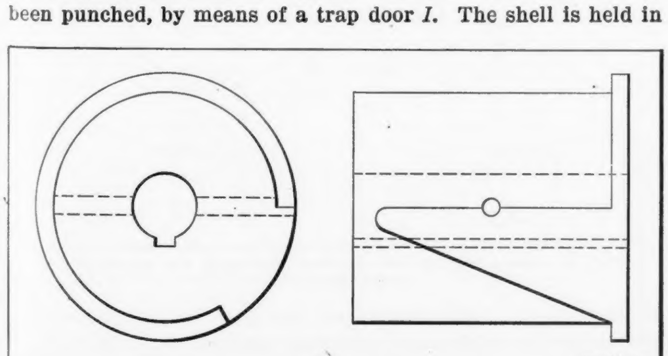


Fig. 3. Cam used on Spiral Perforating Die

position by means of the nut *J* carried at the right-hand end of the shaft *K*. It will be evident from the illustration that the cam *D* which controls the movement of the shell is secured to the shaft *K* by means of a key and pin. Four pins *M* extend into the bore of the die-holder and these pins are engaged successively by the cam *D*. The left-hand hole of a series is first pierced; the ratchet then rotates the shell and the action of the cam moves it to the right. The indexing is effected as previously described, one hole being pierced at each station. After the four holes on one spiral have been pierced and the ratchet starts to index for the next hole, the pin *M* slips over the point of the cam and the tension of the spring *N* then returns the cam and the work to the extreme left where the cam is engaged by the next one of the pins *M*. This process is repeated four times to complete piercing the holes on the four spirals in the shell. The longitudinal movement of the shell is limited by the pin *L* which fits in a slot in the shaft *K*.

C. G.

HAND KNURLING TOOLS

The tools illustrated in Figs. 1 and 2 will be found handy for knurling small stock in the lathe, when the ordinary knurling tool cannot be used on account of the spring of the work.

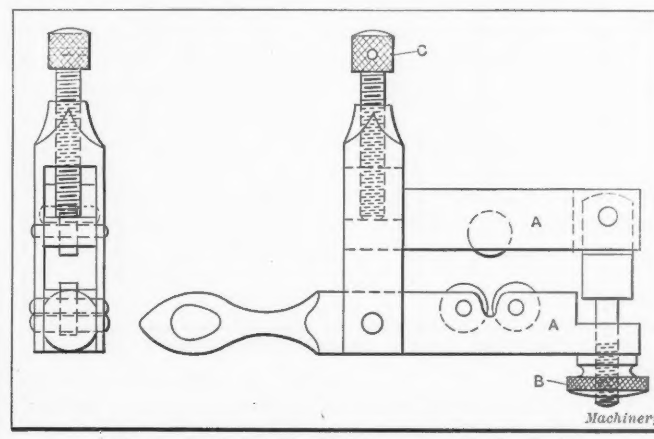


Fig. 1. Hand Knurling Tool for use on Slender Parts

To use the tool in Fig. 1, the bars *A* are adjusted by screw *B*, to come parallel to each other when the knurls are in contact with the work, and the pressure is applied by tightening screw *C*. The tool shown in Fig. 2 is a novelty, but is very cheap and useful. The body *A* is a cheap pair of six-inch pliers having soft jaws which are milled for the knurls. A pair of pliers with parallel opening jaws are the best for this purpose,

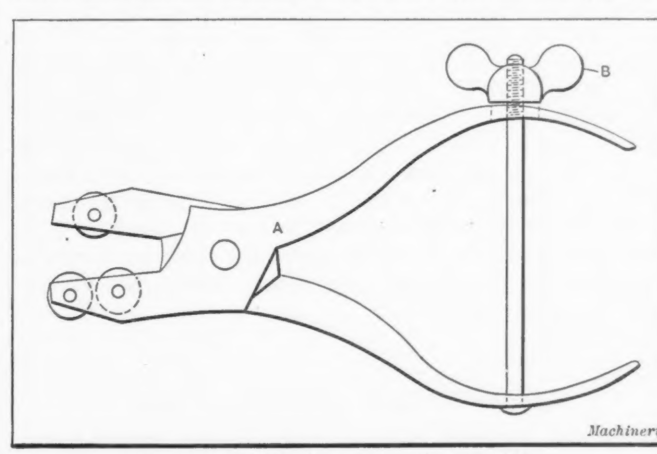


Fig. 2. Hand Knurling Tool made from Pliers

although the common pliers work very well. The illustration is self-explanatory. The pressure for knurling is produced by the thumb-screw *B*.

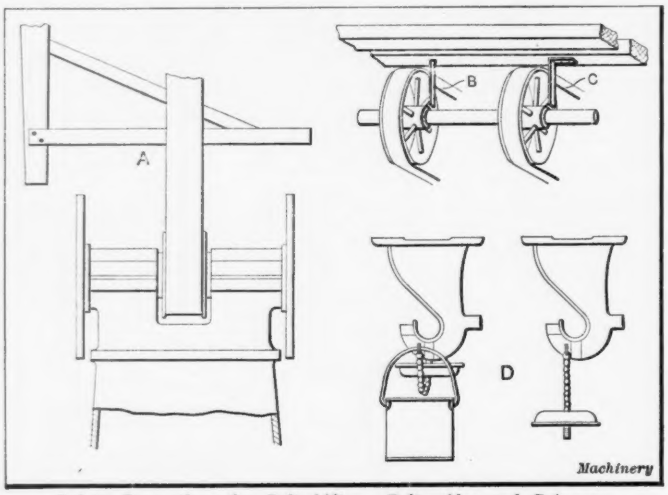
New Britain, Conn. W. C. BETZ

OVERHEAD SAFETY SUGGESTIONS

In the average shop, nearly 50 per cent of the belt shifter handles are located out of the operator's reach when he is in the working position. The danger of having a shifter handle out of reach of the operator is evident, and when such a condition exists, some method should be provided whereby the operator can control the machine from the working position. Similarly, machines such as disk grinders, that have two working sides, should be equipped with double shifter handles or an extension should be placed on the

single handle. An example of this kind is illustrated at *A* in the accompanying illustration.

When a belt on an overhead pulley does not run properly, owing to its having become stretched on one side so that it slips off easily, or from any other cause, it is common practice to drive a pointed rod *B* into the beam on the side of the pulley where the belt has a tendency to run off. Should this rod work loose and fall to the floor, it is more than likely to injure someone passing underneath it. In every case where it is required to keep a belt from slipping off a pulley in this way, a forged bracket should be made and screwed onto the beam as shown at *C*. Such a method is but a makeshift at best, but where a bracket of this kind is screwed into place it cannot work loose.



Safety Suggestions for Belt-shifters, Belt-guides and Drip-cups

Accidents from falling drip-cups occur from time to time. There are few instances, however, in which any provision is made for securing drip-cups to the hangers, in order to prevent them from falling in case they become unscrewed due to the vibration of the shafting. To provide for the safety of those working under the shafting in shops, all drip-cups should be periodically inspected, and they should be fastened in such a way that they can be unscrewed in order to enable the oil to be emptied from them while they are still attached to the hanger. The right-hand illustration at *D* shows what happens when a cup becomes unscrewed or slips out of the workman's hand while he is attending to it. It will be seen that the drip-cup is secured to the hanger by a chain so that it cannot fall. Provision should also be made for the oiler or attendant to hang his pail on the hanger while attending to his work. The hook that holds the chain to the hanger could be utilized for this purpose, the idea being clearly shown in the illustration. Such an arrangement gives the oiler the free use of both hands when attending to the drip-cups.

Hartford, Conn. JAMES E. COOLEY

REMOVING A BROKEN TAP

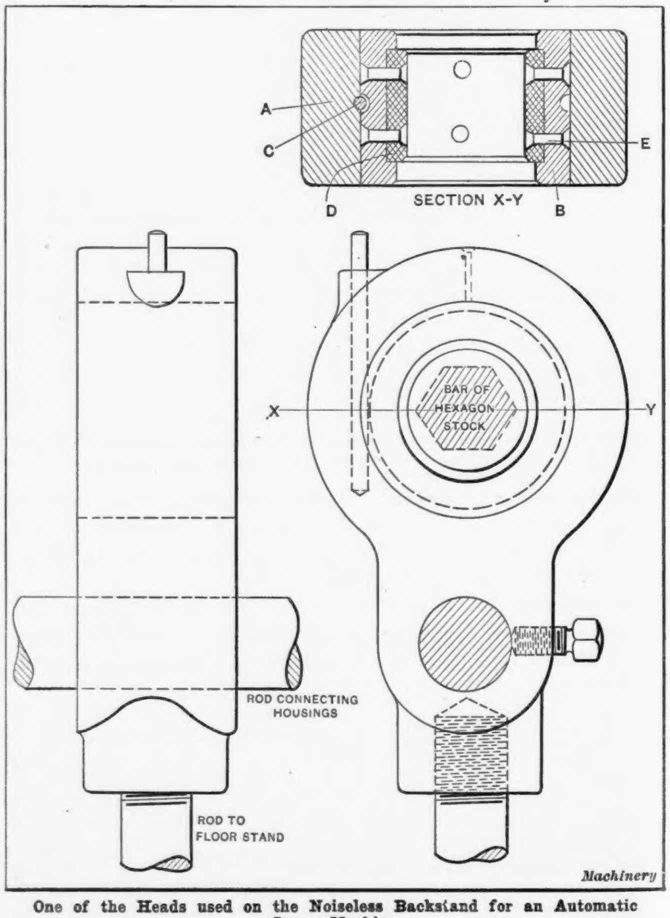
Of all the numerous ideas which have been applied in removing a broken tap, the use of a mixture of sulphuric and muriatic acid seems to be one of the best. In using this method, the first step is to clean all grease and other foreign matter from the hole, using either gasoline or heat for this purpose. Then apply the acid, a few drops at a time; in doing this, particular care must be taken if the tap is bottomed in the hole. The acid cuts both ways, reducing the size of the tap and enlarging the size of the thread, and after a short time the tap can be easily backed out with an extractor or an ordinary pair of pliers. After the acid has been applied, a constant pressure should be maintained on the tap in order to back it out as soon as possible. The hole is then washed out with water to prevent the metal being attacked any more than is absolutely necessary. The use of a little white chalk or alkali in the water is beneficial, as it tends to neutralize the acid and stop all further action. The application of heat will accelerate the rate at which the acid works. The idea is to cut a chip which is formed by the teeth of the tap. Of course where the tap is bottomed hard, a clearance has to be eaten away by the acid, as previously described.

Erie, Pa. A. N. HAMMOND

BACKSTAND FOR AUTOMATIC SCREW MACHINE

The backstand head for an automatic screw machine, shown in the accompanying illustration, was designed to eliminate the noise caused by bars of stock rattling around in the ordinary style of backstand. This improved backstand head consists of a cast-iron housing *A* in which a steel bushing *B* is held in place by a retaining pin *C* in such a manner that the bushing is free to rotate. The center line of the retaining pin is in line with the outside of the bushing, thus allowing half of the pin to enter a groove in the bushing and hold it in place. The groove is of such a size that the pin fits freely in it. The bushing is recessed on the inside to accommodate a piece of double thick leather belting *D* which is fastened to the bushing by brass rivets *E* with countersunk heads. The grip of the leather on the bar stock causes the bushing to rotate, thus distributing any wear which may occur. Bushings of this style are made in three sizes suitable for different diameters of stock.

Three heads of the type illustrated make up a complete backstand, thus supporting the stock at three points and preventing any "whipping" action on account of the short distance between the heads, which is about thirty inches. We have had a stand of this type in use for several months and have found it entirely satisfactory. The stock handled by this particular machine varies from 1 to 2 inches in diameter by 12 feet in length. At present, we are planning to put the same style of backstand on other machines which we are using.



One of the Heads used on the Noiseless Backstand for an Automatic Screw Machine

Chicago, Ill. R. W. ULLMANN

* * *

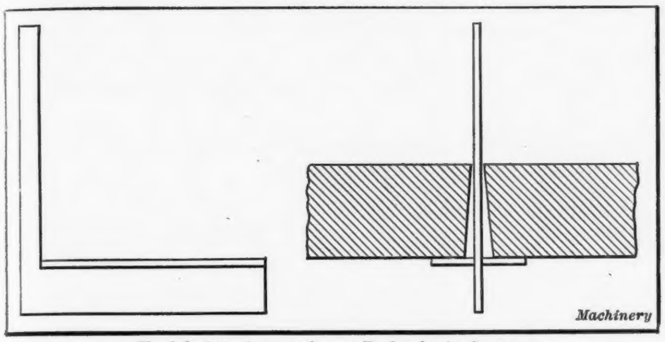
A new soft solder which is said to possess superior properties and to be less costly than ordinary lead-tin solder contains approximately 41.5 per cent tin, 2 per cent antimony, and 0.02 per cent phosphorus, with the remainder lead.

SHOP AND DRAFTING-ROOM KINKS

INGENIOUS MEANS AND SHORT CUTS FOR SAVING LABOR AND MATERIALS

TOOLMAKER'S SQUARE

Small squares or angle gages of the kind used by toolmakers when filing out a blanking or piercing die will be found much more useful if a flat piece of steel is soldered onto the inside of the stock. This piece of steel is brought exactly square with the blade, the arrangement being clearly shown in the accompanying illustration. It will be evident that such a square can be used to advantage when making a narrow die which will only take the blade of the square edgewise. In addition to this application, a square fitted up in this way will be found useful for many other toolmaking operations.



Useful Attachment for a Toolmaker's Square

Meriden, Conn. JAMES GALLIMORE

SCALE OF FRACTIONS AND DECIMAL EQUIVALENTS

Of the numerous tables that a draftsman has to have for constant reference, one of those most frequently used is a table of fractions and decimal equivalents. Tables of this kind have been prepared in many different forms, the aim being to produce a form that will give the results in the quickest and easiest way. The accompanying illustration shows a diagram of fractions of an inch and corresponding decimal equivalents which takes the place of tables and is, in the writer's opinion, more convenient for many classes of work than an ordinary table would be. Such a diagram can be easily constructed by any draftsman, a pair of bow-dividers used with ordinary care enabling it to be laid out within the required limits of accuracy. Most of the calculations made by a draftsman do not involve the use of fractions smaller than 1/64 inch and as 0.01, or the second decimal place is smaller than a sixty-fourth, it is useless to use a smaller decimal. Regardless of this fact, many tables of decimal equivalents for fractions up to 1/64 inch are carried out to the fourth, fifth and even sixth decimal place.

The accompanying diagram gives the decimal equivalent of sixty-fourths of an inch to the second decimal place direct, and when desired the third decimal point can be readily estimated. The great convenience of this diagram lies in the fact that it shows at a glance the relative values of fractions of an inch and the corresponding decimal equivalents.

Meadville, Pa. C. H. FARIS

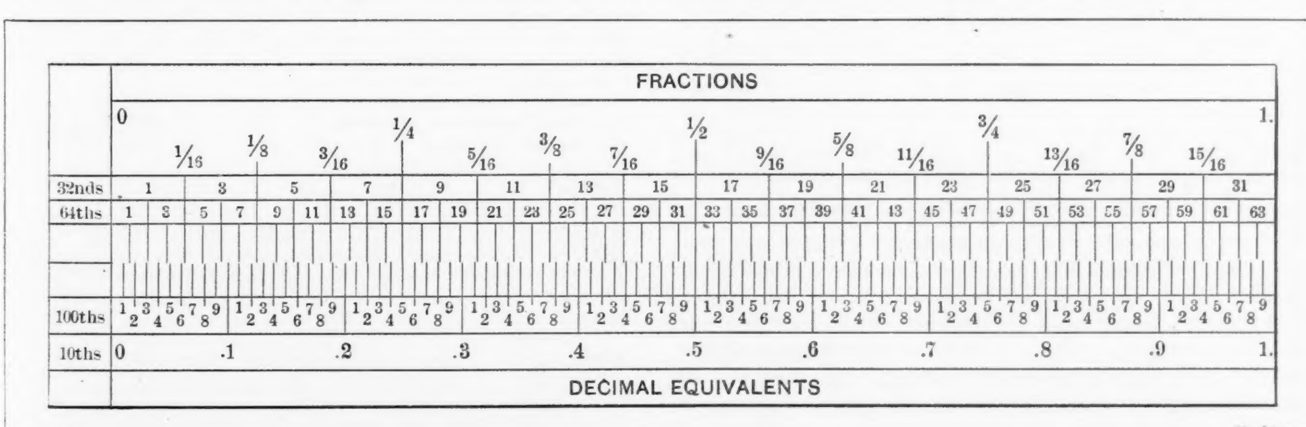
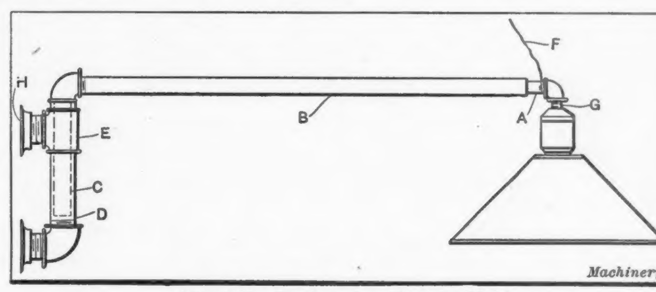


Diagram of Decimal Equivalents, giving Exact Values of Second and Approximations of Third Decimal Place

ADJUSTABLE DRAFTING-ROOM LIGHT

A serviceable form of adjustable lamp bracket for use in the drafting-room is illustrated herewith. This bracket is designed to be attached to the wall or to a window casing and may be used directly in front or to one side of the drawing board. Referring to the illustration, it will be seen that the bracket is made entirely of pipe and pipe fittings, the pipe being cut to the required lengths and threaded at one end only. Horizontal adjustment is secured by slipping the pipe *A* in or out of the pipe *B*, and vertical adjustment is obtained by raising the pipe *C* in pipe *D*. The overhang of the bracket will clamp the pipe *C* sufficiently to hold it at the desired height without the aid of a thumb-screw or other binding device. Any angular adjustment may be obtained by swinging the pipe *C* in pipe *D*.

In making the parts, a drill is run through the ¾-inch tee *E* in order to remove the threads so that it will slip over the end of the ¾-inch pipe *D*. This tee is only used as a brace and when it is screwed onto the ¾-inch nipple, the pipe *D* is held in a vertical position. The ⅜-inch pipe *C* slips into the pipe *D* which is made of double strength pipe in order to give a tighter fit. The ⅛-inch pipe *A* slips into the ⅜-inch pipe *B*. A hole is drilled in the pipe *A* close to the elbow to receive the lamp cord *F* which passes down through the elbow and nipple *G* to the lamp socket. The lamp socket screws directly onto the nipple. It is evident that the bracket is secured to the wall by means of screws fitting into the flanges *H*. Dimensions have been omitted from the illustration, as the bracket will naturally be made of different sizes to meet the requirements of individual cases.



Adjustable Bracket for Electric Light

Three Rivers, Mich. C. DON MCKIM

* * *

Don't, when a drill gets stuck in a jig, lower the table and try to drive the jig down while it hangs on the drill; knock the drill out of the spindle and remove it from the jig by attaching a dog to it.

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

DRAWING BRASS TUBING ON STEEL RODS

Answered by C. Fred Gorham, Chicago, Ill.

In answer to the query by G. W. A. in the November number of MACHINERY, regarding drawing brass tubing onto steel rods, I would suggest that instead of drawing or rolling the tubing onto the rod, the following method would give more satisfactory results. Rough-cut the required length of rod in a lathe without lubricating the tool, so that the rod will be perfectly clean but not smooth. Then heat the rod and cast brass around it without using a flux. After the brass has cooled, set the work up in a lathe and turn it down to the required size. The rod should be heated to about the same temperature as the molten brass, but neither the rod nor the brass should be hotter than is necessary to let the brass run freely. The rod should be heated immediately before the casting operation and should not be held at a high temperature any longer than necessary.

PERMANENT SET OF CAST IRON

P. A. L.—I am repairing air cylinders used for opening and closing the doors of elevated cars. Cast-iron spreaders are used to hold the leather packing rings out against the cylinder. I have found a number of these cast-iron spreaders collapsed after being several months in use, which indicates that cast iron can take a permanent set. My foreman says that there is no such thing as a permanent set to cast iron.

A.—Cast iron will undoubtedly take a slight permanent set. The softer the iron the greater the amount of set it will take. This is shown by common experience with piston rings, especially when made of soft cast iron. Often piston rings will be found in a collapsed state, being smaller than the cylinder bore by an amount considerably greater than that due to wear. A common expedient is to peen the inside of the rings, thus giving the rings a permanent set and enlarging the diameter sufficiently to fill the cylinder bore.

CHANGE OF LUMEN METAL BUSHINGS ASSEMBLED BY PRESSURE

H. K.—About sixteen months ago I finished a stock order for our company consisting of a large number of steel shrouds into which "Lumen" metal bushings had been pressed. After being pressed into place the bushings were reamed out to 1.5 + 0.002 inch (1.502 inch), to form a running fit on the shaft. The shafts were made of cold-rolled steel and did not vary more than 0.0005 inch under or over 1.500 inch. The reason for allowing only 0.001 to 0.0025 inch clearance is that the shafts rotated very little in the bearings. After being carefully inspected the parts were boxed and placed in the storehouse ready for use. A few weeks after, we had occasion to send a number of these parts to a contract job, and the construction men found on opening the boxes that the shafts would not enter the reamed holes in the bushings. On inspection we found that a plug gage 1.495 inch would not enter the holes. What was the cause of the trouble?

Answered by Bierbaum-Dollar, Inc., consulting engineers, Lumen Bearing Co., Buffalo, N. Y.

It would be difficult to make an experiment that would show more characteristically a peculiar physical property of "Lumen" metal, an alloy having a compressive strength of 70,000 to 80,000 pounds per square inch. That it should flow under pressure as much as indicated in the foregoing experience will seem rather strange to anyone who has had occasion to observe it for the first time, but that it does act in this way is well attested by our experience. One of the most difficult problems we encountered in the early history of the "Lumen" business was that we could not give satisfactory bushing service. But after experimenting and noting the experience of large users we arrived at the conclusion that "Lumen" bushings must never be forced into a bearing—in other words, made a forced fit. We recommend that all bushings be made a loose fit, or so they can be driven into place with a light pine wood block. Set-screws should be provided to hold the bushing in place. These set-screws should not bottom against the bushing, but should fit in holes drilled deeper in the bushing than the length of the projecting end of the set-screw. Our rule for journal clearance in "Lumen" bushings is 0.001 inch plus an additional 0.001 inch for every inch diameter of the journal. For example, a five-inch bearing should have a clearance of 0.006 inch.

TRADES WAGES IN NEW YORK CITY

F. D. J.—What are the prevailing rates of wages for the building trades, mechanics, etc., of New York City?

A.—The building trades wages per day for 1914 as specified by the United Board of Business Agents, New York, are as follows:

Asbestos workers, boiler felters, pipe coverers, insulators	$4.75
Asbestos workers' helpers	3.00
Blue stone cutters, flaggers, bridge and curb setters	4.50
Blue stone cutters' helpers	3.00
Boilermakers and iron ship builders	5.00
Boilermakers' helpers	3.50
Bricklayers	6.00
Bricklayers' helpers	3.00
Carpenters and framers	5.00
Cabinet makers	5.00
Cement and concrete masons	5.00
Cement, concrete and asphalt laborers	3.00
Derrickmen and riggers	4.00
Decorators and gilders	4.50
Decorative art glass workers	5.00
Elevator constructors	5.28
Elevator constructors' helpers	3.40
Electrical workers	4.80
Electricians' helpers	2.20
Electrical fixture workers	4.80
Engineers, portable hoisting, etc., $30.25 weekly; by the day	6.00
Engineers on boilers, pumps or pile driving machines, per week	30.00
Engineers, stationary	4.50
Framers	5.00
Granite cutters, $5.00 yard; bridge	5.50
House shorers, movers and sheath pilers	3.75
House shorers' helpers	2.65
Housesmiths and bridgemen	5.00
Ironworkers	5.00
Ironworkers' helpers	3.50
Ironworkers' apprentices	3.00
Metallic lathers	5.00
Marble cutters and setters	5.50
Marble carvers	6.00
Marble polishers	4.40
Marble sawyers	4.65
Marble bed rubbers	4.90
Marble cutters' helpers, $3.25; rigging and crane operators	3.75
Mosaic workers	4.50
Mosaic workers' helpers	3.00
Machine stone workers	4.00
Machinists of all description	5.00
Plate and sheet glass glaziers	3.50
Plasterers, plain and ornamental	5.50
Plasterer modelers, per week	$30.00 to 100.00
Plasterers' laborers	3.25
Plumbers and gas fitters	5.50
Painters	4.00
Painter-decorator, painter-striper, painter-gilder	4.50
Painter-letterer, painter-grainer, painter-varnisher	4.50
Riggers on machinery, dynamos, boilers, etc	4.00
Roofers, tar, felt, composition, damp and waterproofers	4.25
Rockmen	2.50
Rock drillers and tool sharpeners, open work, $3.68; tunnel	3.75
Sheet metal workers, coppersmiths, tinsmiths, metal roofers	5.00
Slate and tile roofers	5.00
Steam, hot water and general pipe fitters	5.50
Steam fitters' helpers	3.00
Tile layers	5.50
Tile layers' helpers	3.25
Tunnel and subway constructors	3.75
Upholsterers of all description	4.50
Varnishers	4.00
Wood lathers on new work, $3.50 per M; overhauling jobs	5.00

Foremen's wages range from fifty cents to a dollar a day more than the schedule. All legal holidays and Sundays are figured at double time.

* * *

During 1913 approximately 30,000 applications for patents were made in the United Kingdom, 500 relating to aeronautics.

MACHINING A TRIPLE STAGGERED TOOTH GEAR

A steel gear that is very unusual and probably the largest of its kind ever built was shipped recently by the Mesta Machine Co. of Pittsburg, to the Inland Steel Co., Chicago, and will be used for driving a sheet mill. By the use of this gear and its mating pinion, a single-stage speed reduction is obtained from the motor to the mill. The accompanying illustration Fig. 1 shows this gear in the company's works at West Homestead, Pa. The diameter of the gear is 22 feet, 8 inches, the face width 38 inches, and the circular pitch 5½ inches. The mating pinion is 2 feet 11 inches in diameter. There are 154 teeth in the gear and 20 teeth in the pinion.

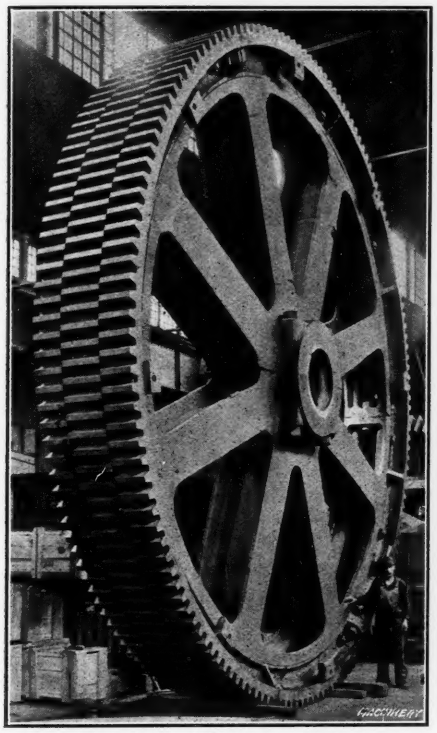


Fig. 1. Large Gear built by the Mesta Machine Co.—Diameter, 22 feet 8 inches; Circular Pitch, 5½ inches; Face Width, 38 inches

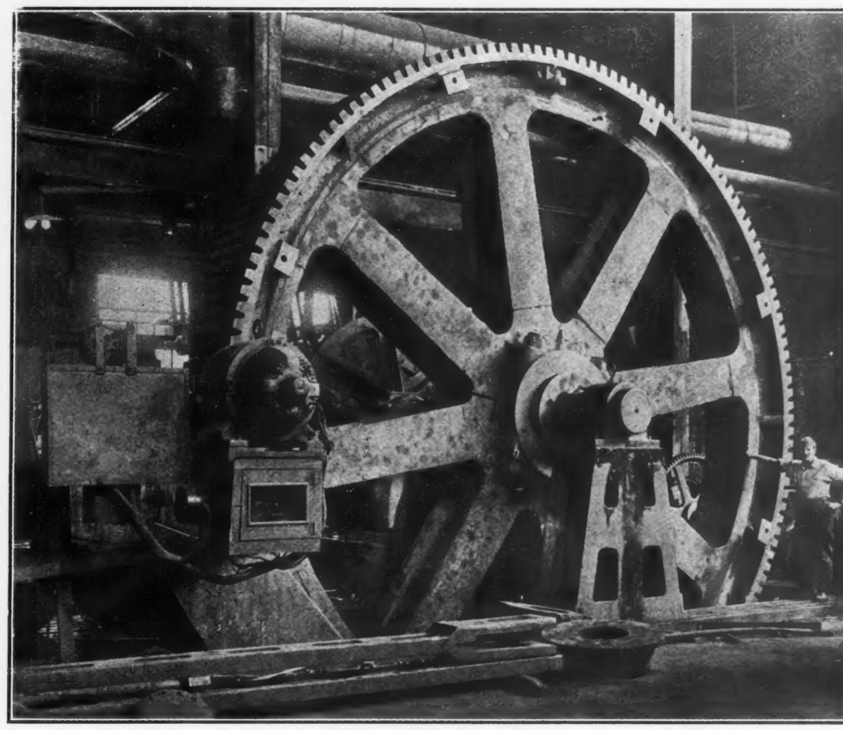


Fig. 2. Large Gear and Special Planer used for cutting the Teeth—Outer Sections of Rim were shifted after Teeth were cut to stagger the Teeth as shown in Fig. 1

The design varies from ordinary practice, the teeth being staggered, as the illustration shows. The gear is built up of six parts. The gear center, including the arms, etc., carries the central rim in which the central row of teeth are cut. The outer rows are cut in separate rims that do not form an integral part of the central casting. The two halves of the gear were bolted together and the separate rims fastened to the central part by bolts extending through the casting. On account of the axial motion to which the gear is subjected, it was necessary to use a spur gear. Herringbone gears were not considered because of the unequal pressures that would be exerted on the sides of the tooth faces. The gears have a peripheral speed of 2000 feet per minute. Because of this high speed the teeth were not only staggered, but very carefully cut, and the drive arranged to run in an oil bath.

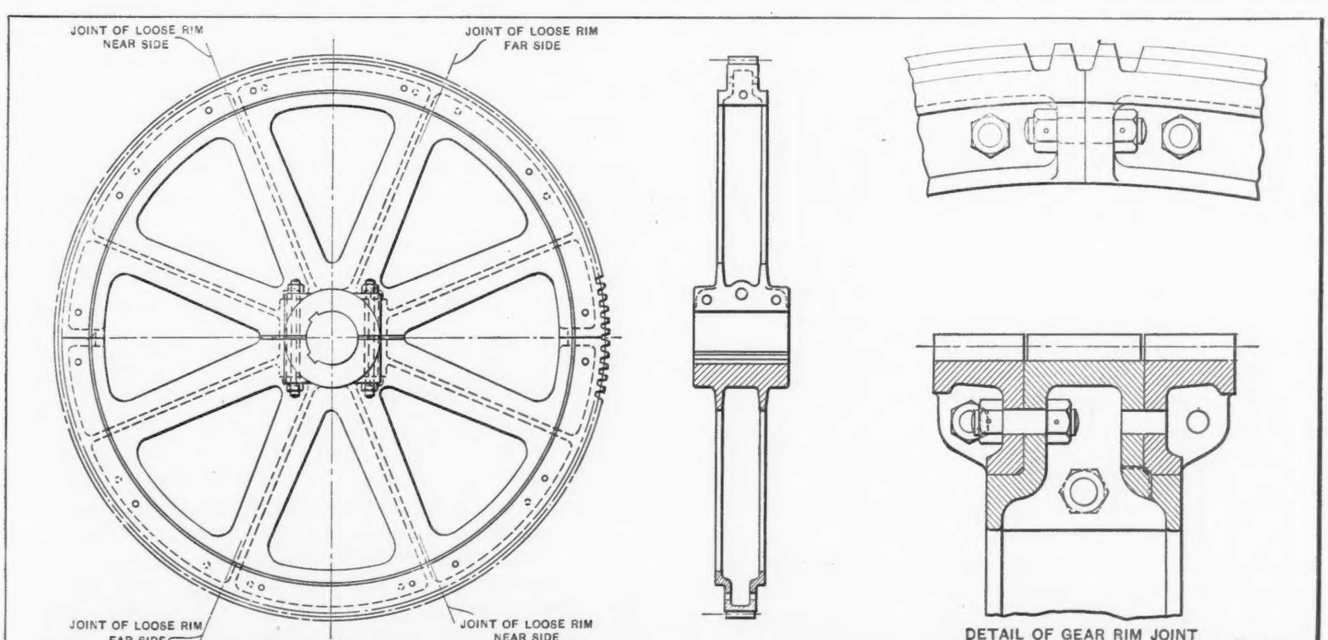


Fig. 3. Large Triple Staggered Tooth Gear made by the Mesta Machine Co.

The method of machining the gears is very interesting. All the teeth were cut on a planer (shown in Fig. 2) designed and built by the Mesta Machine Co. For such large work, crank-operated tools were found too yielding and, consequently, a special planer was built. The tool of this planer is driven directly by a heavy lead-screw, which, in turn, is operated by a variable speed reversing motor. Starting with the rough casting, the operation of machining this gear will be described. After annealing the casting, the joints at the hub and rim of the central part of the gear were planed. These joints were then drilled, reamed and the two halves

of the central section bolted together. The wheel was then placed in the pit lathe and the gear center was turned down to the correct diameter; the surface or fitting for the rim segments was also machined. The main gear was then removed from the lathe and the rim segments machined. Lugs were cast on these segments to aid in holding the work onto the faceplate. After bolting a segment onto the faceplate, one side was turned; it was then reversed, the other side machined and the segment turned to the required diameter. The surface of the segment that was to rest on the main gear was also machined at this time.

The rims were next bolted securely to the main gear center with all the rough teeth in alignment across the face of the gear, as shown in Fig. 2. The teeth were then planed through the center and side sections at the same time. The final cut was taken without removing the tool during the entire operation of cutting.

The method of machining the mating pinion was, in a way, similar to that employed for the large gear. After the teeth were cut the bolts were taken out and the two side sections shifted around the center section to give the proper stagger to the teeth. This was done by using an indicating micrometer so that the slightest variation from the required dimensions could be detected. After the teeth of the pinion were staggered, the teeth of the large gear were set to match those of the pinion. Holes were then drilled through both outer rims and the center of the gear, and after these holes were reamed, machined bolts were inserted. The gear was then taken apart and shipped. Inasmuch as the gear is built up of six parts which are fitted together at the plant with machined bolts, its installation will be very simple and it will not be necessary to disturb the machinery already installed.

* * *

THE PARIS AEROPLANE EXPOSITION

The Fourth International Exhibition of Aerial Locomotion, which was held in Paris last December, indicated the keen interest that is taken in all matters pertaining to aviation. The exhibition showed clearly that the aeroplane has reached fixed and definite types. Its development in this respect is similar to that of the automobile. There were no longer displayed the startling novelties and innovations seen in the earlier exhibitions. The monoplanes were exceptionally prominent, and most of them were provided with an enclosure or metallic hood for the motor and pilot, affording protection from wind and storm, and, in military machines, from bullets fired from beneath. All parts of the machine—motor, wings and maneuvering apparatus—were stronger and more durable than in the past. The most marked improvements that have been made are almost exclusively in the direction of stability and safety from breakages and failure of parts. Experience has also taught that with a powerful and trustworthy motor the great spread of wing which was formerly thought essential is not necessary. Great improvements have been made in motors and the best of those exhibited have really attained a standard of reliability very near perfection. These motors have made possible the long continued flights without descents which have marked the past year and which were considered impossible only two years ago, the record being a continuous flight of over 500 miles in somewhat more than eight hours.

There was an interesting and large display of hydro-aeroplanes. The majority of these, as well as of the other types exhibited, were intended for military use, many being protected by armor and fitted with quick-firing rifles. Besides the aeroplanes, there was exhibited a huge military car for a dirigible, which was about 30 feet in length, enclosed in a bullet-proof armor and equipped with quick-firing guns and a complete wireless telegraphy outfit.

The only important American exhibit was the new Curtiss four-passenger hydroplane which is essentially a motor-boat with a biplane attached to it. It was the only four-passenger machine in the exhibition. It has a speed record of sixty miles an hour and is especially adapted to meet the requirements of naval service. The exhibition was attended by a large number of military and naval officers from all countries, who studied every detail of the latest improvements with a view to the requirements of their own army and navy service.

* * *

DIFFERENCE IN ACTION OF PLANING AND MILLING CUTTERS

BY H. A. S. HOWARTH*

Reference was made in the March, 1913, number to the marked difference in all planer tools and face milling cutters on the grids of magnetic chucks, quoting from the experience of the Walker Magnetic Chuck & Grinder Co. Mention was made of the tendency of cast iron to break out at the edge as the planer tool passes over the edge when it completes the cut, whereas with the face milling cutter the tendency to break at the edges of the grids is much less pronounced. Let us assume that the planer tool is ground exactly the same as one of the inserted blades of the face mill, which is a reasonable assumption because it leads us to look elsewhere for the answer. Following are some differences in the action of the two tools:

(1) The path of the planer tool is straight while that of the milling cutter is curved; (2) the planer tool crosses an edge at right angles while the milling cutter crosses at an angle varying from 0 to 90 degrees; (3) the planer tool takes a heavy cut, usually with a single cutting edge, while the milling cutter takes a light cut with each of several cutting edges; (4) the planer tool lacks the support or control of other edges cutting at the same time, thus it is free to jump forward as soon as the resistance ahead of it is reduced; the milling cutter presents several cutting edges to the work at one time and hence only one edge begins or ends its cut at a time; the rest of the cutting edges under cut are buried in the metal, thus preventing the departing cutter jumping forward; (5) the cutting speed of the planer is likely to be much less than that of the milling cutter because of the difficulty of reversing the table when moving at high speed. Obviously, there is no such condition limiting the speed of the milling cutter. (6) The planer in most cases when small has a pinion, gear and rack drive for the table. The driving mechanism is full of spring, due to the twisting shafts. The milling machine table almost invariably has a screw feed for the table. The milling cutter has a gear drive usually, and this corresponds in a large degree with the gear drive of the planer table, as far as jumping effect is concerned.

Looking over the above comparisons, it seems probable that (3), (4), (5) and (6) explain the difference in action noted. The planer tool is given a comparatively heavy feed in order to get the work out quickly. The result is that the tool jumps forward at the end of this cut and breaks off a piece that extends slightly below the planed surface. The milling cutter takes several fine chips at once and only one breaks over the edge at a time. Hence, the cutter does not jump forward because it is supported by several other cutting edges. The screw feed of the milling machine table steadies its motion and to a large degree removes the tendency to jump.

* * *

NEW SIZE JOURNAL, A. S. M. E.

The *Journal* of the American Society of Mechanical Engineers has been enlarged from 6 by 9 inches to 9 by 12 inches. The new size of page favors the presentation of tables, large diagrams, etc., and it will rarely be necessary to resort to inserts and folders, which are costly and inconvenient to the reader. The transactions of the society will not be bound and distributed to the members hereafter. The numbers of the *Journal* will contain the complete transactions and should be kept and bound if the members wish to preserve them.

* * *

During 1913, out of a total of nearly 3200 passenger cars ordered for the railways in the United States, 2765 were of steel, 171 were steel under-frame, and only 177 were of wood; the construction of the remainder is not specified. There is also a very marked increase in the use of steel-frame box cars.

* Address: 3732 Dawson St., Pittsburg, Pa.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

CLEVELAND ROTARY TILTING MAGAZINE

The rotary type of tilting magazine, front and rear views of which are shown in Figs. 1 and 3, is a recent product of the Cleveland Automatic Machine Co., Cleveland, Ohio, that has been developed for use in connection with the Cleveland "automatic." This attachment is used on second-operation work and is shown producing pieces of the form illustrated in

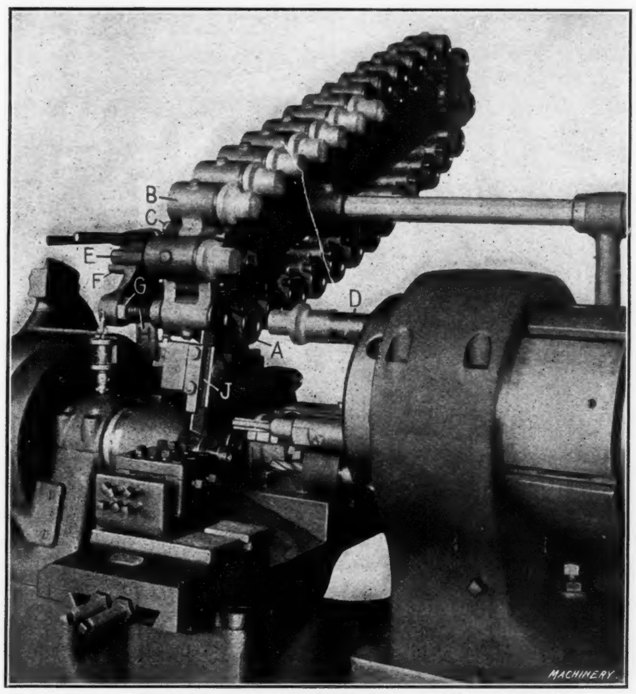


Fig. 1. Front View of Cleveland Rotary Tilting Magazine

Fig. 2. These pieces are produced from cast-iron blanks and it is necessary in this case to separate the work that is gripped in the chuck from the remaining portion. For this purpose the independent cut-off is used. Pieces of this type were produced in five minutes with an actual labor cost of one-half cent. A feature of the attachment is that a bushing required for a large piece of work can be provided with internal bushings to adapt it for holding smaller sized pieces. Occasionally when the magazine is used for some odd shaped piece that has surface enough to grip in the chuck, it is

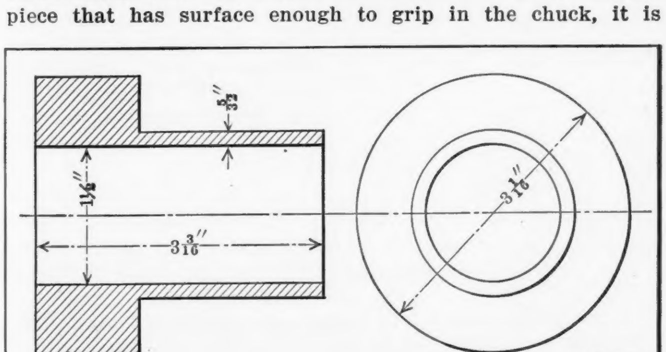


Fig. 2. Example of Work handled by Cleveland Rotary Tilting Magazine

necessary to employ a simple form of latch held by a spring to keep the piece from falling out. This statement applies only to second-operation work and is referred to to show that the magazine may be employed for practically any shaped piece upon which a second operation must be performed. Aside from the tools required for different jobs, the only special equipment necessary is bushings of the required size.

Fig. 1 shows the magazine in the working position. The magazine tilts to the working position and after the piece has been removed it rises to clear the turret tools. In this respect it is similar to the original form of tilting magazine built by this company, but differs from the preceding design in that the parts to be machined are placed in the bushings *A* which are mounted in the links *B*. This arrangement permits of handling a greater variety of irregular shaped parts than was possible with the original form of magazine, where the parts were laid one upon the other and guided by parallel bars. The chain composed of the links *B* is indexed by means of the lower pair of sprocket wheels *C*, one of which is provided with a series of pins that engage an index pawl—not shown in the illustration. This pawl rotates the sprockets upon the downward tilt of the magazine and brings each link *B* in line with the conveyor *D* in the turret hole; upon the upward tilt, the pawl drops down and engages the pin following the one that has acted upon it. The sprocket shaft *E* rests in the saddle *F* on the main supporting arm *G*, which serves as a stop and also maintains the required alignment while the conveyor is removing the part to be machined.

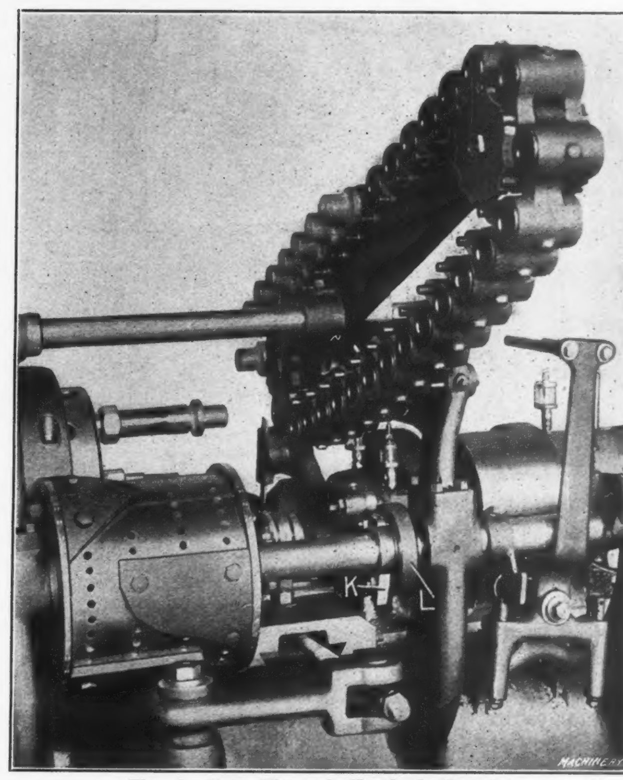


Fig. 3. Rear View of Cleveland Magazine

The adjustable stop *H* mounted on the main supporting arm prevents the conveyor straining the magazine while removing the work from the bushing. Fig. 3 shows the cam *K* and the disk *L* that are employed to operate the independent cut-off attachment. The cam and lever which operate the magazine are mounted on the cam-shaft at the extreme left of Fig. 3, and are not shown in the illustration. This magazine does not interfere with the use of the independent cut-off attachment shown at *J* in Fig. 1, or with the operation of the machine on bar work.

LANGELIER DRILLING AND TAPPING MACHINE

The four-spindle horizontal drilling and tapping machine shown in Figs. 1 and 2 is a recent product of the Langelier Mfg. Co., Providence, R. I. This machine is intended for drilling and counterboring or for tapping four holes simultaneously. An idea of the classes of work for which it is adapted will be obtained by referring to Fig. 3. The positions of the spindles are adjustable to enable the machine to handle a great variety of work. Machines of this type

are built with different numbers of spindles and in different sizes. The four-spindle machine shown in Figs. 1 and 2 has a capacity for drilling and tapping holes up to ⅜ inch in diameter in cast iron, mild steel, brass and other metals. The height from the top of the fixture platen to the center line of the spindles is 5¾ inches, which allows plenty of room for handling work or jigs of considerable size.

The two heads at each end of the machine may be moved back until the ends of opposing spindles are 18½ inches apart, or the heads may be advanced toward each other until the distance between the ends of the spindles is only 8½ inches. The front spindle at each end of the machine is provided with transverse adjustment so that these spindles may be located at distances ranging from 1¼ to 3½ inches from the center line of the rear spindles. This adjustment is ob-

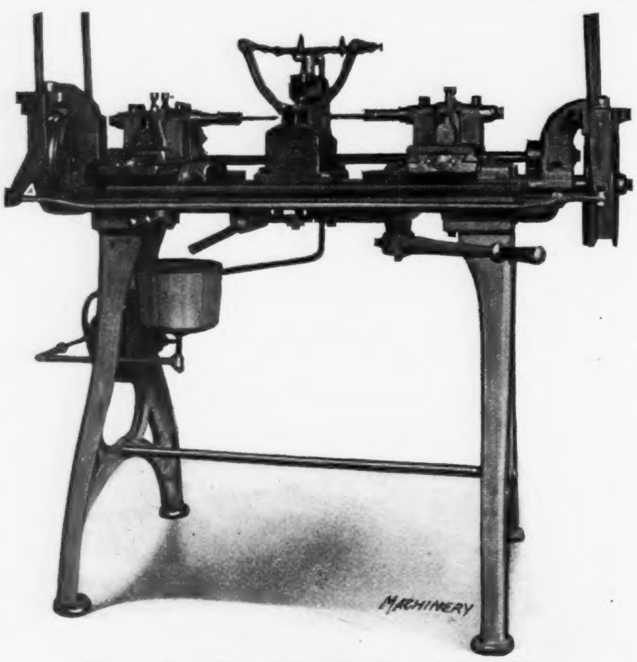


Fig. 1. Front View of Langelier Four-spindle Drilling and Tapping Machine

tained by a cross-slide and screw. Each head is mounted separately on a finished and gibbed saddle interconnected with the feed. The two heads at each end of the machine are withdrawn as a unit by manipulating a single hand lever. Positive adjustable stops are provided for accurately controlling the movement of the saddles so that work produced by an unskilled operator will be uniform, and time losses resulting from over-travel of the saddles are eliminated.

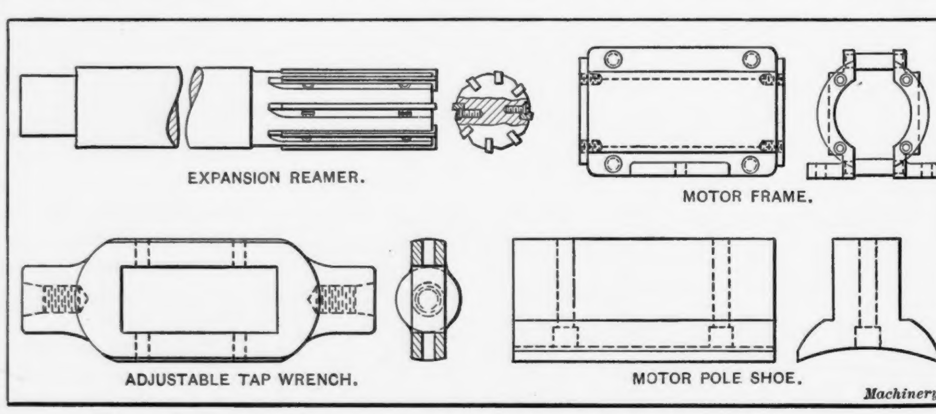


Fig. 3. Examples of Work done on Langelier Drilling and Tapping Machine

The spindles have No. 1 Morse taper to receive drill chucks or tap-holders with No. 1 taper shanks. A hard phosphor-bronze gear is keyed to each spindle and driven by a steel driver mounted at right angles to the spindles. The cross-shafts on which the driving gears are mounted are driven from the main horizontal shaft at the back of the machine through another right-angle spiral gear drive. Drilling and tapping thrusts are carried by hard phosphor-bronze and hardened steel washers, and means are provided for taking up end-play.

The machine is driven by tight and loose pulleys which are grooved to carry built-up round leather belts located at the left-hand end of the main driving shaft. Round belts were selected for this purpose because the machine can be reversed with them more quickly than would be possible if flat belts were used. In fact, reversal may be obtained almost simultaneously and without any slipping of the belt. As previously stated, the spindles are driven by the pulleys at the left-hand end of the machine. For tapping operations, when the stop governing the depth to which the work is to be tapped is reached, the tap-holders unclutch and the operator shifts the driving belt to the loose pulley. In so doing, the reverse driving belt at the right-hand end of the machine is shifted from the loose to the tight pulley, thus reversing the direction of rotation of the spindles and backing the taps out of the holes. The taps are backed out at a faster speed than that at which they are fed into the work. The change of

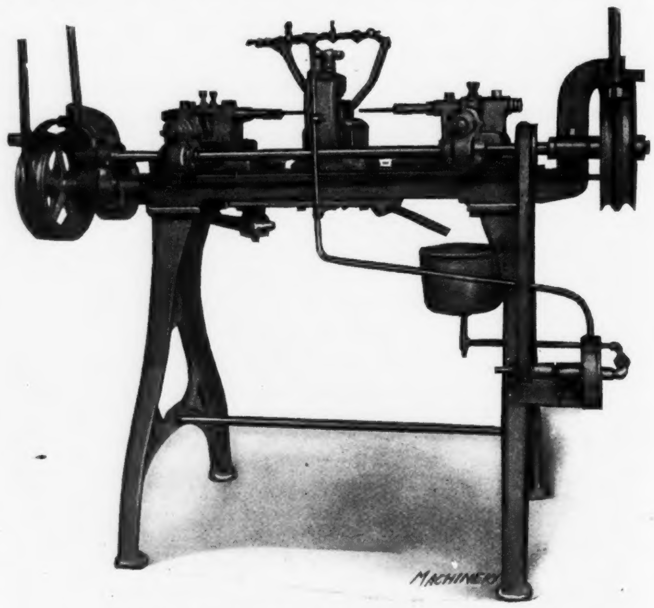


Fig. 2. Opposite Side of Machine shown in Fig. 1

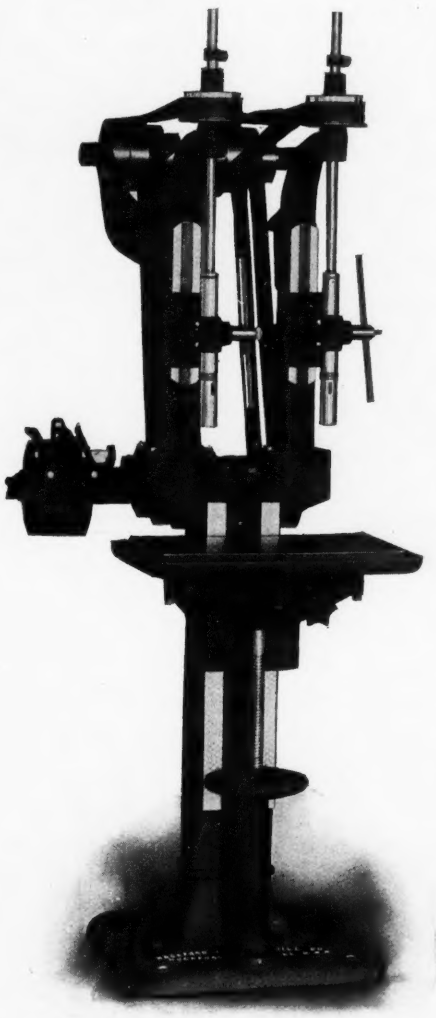
speed and direction of rotation is obtained without employing crossed belts, by the use of accelerating gears interposed between the jack-shaft and the main horizontal driving shaft. A special countershaft has been designed for use in connection with this machine which provides two drilling and two tapping speeds.

The flow of oil is under the direct control of the operator. Suitable flexible piping connections with pet-cocks lead the oil supply delivered by the rotary pump to the required points. This pump is located at the back of the machine, as shown in Fig. 2, where it will be seen that it is belted to the main driving shaft. All surplus oil and chips are retained on the bed of the machine by the high rim which runs around it. The oil runs into a self-straining reservoir which is piped to the pump suction. In this way the oil is kept in constant circulation without requiring any attention from the operator. Efficient oilers are provided for lubricating the spindles, gearing and other moving parts. This machine occupies a floor space of about 24 by 60 inches; the height from the floor to the spindles is 42 inches, and the weight of the machine is 1750 pounds.

ROCKFORD MULTIPLE SPINDLE DRILL

In the design of a line of multiple spindle drills which has been brought out by the Rockford Lathe & Drill Co., Rockford, Ill., the idea has been to produce a simple and accurate machine that is convenient to operate and of ample weight to meet the requirements of modern manufacturing

methods. Referring to the accompanying illustration, which shows one of these machines, it will be seen that the column is of the box type. The table is raised and lowered by a handwheel and has adjustable supports. It may be removed for replaning in event of its becoming badly worn. The spindles are made of high-carbon steel, forged and accurately ground. Ball-thrust bearings and stop-collars are provided,



Rockford No. 210 "Economy" Floor Drill

and the spindles are counterbalanced by chains and weights.

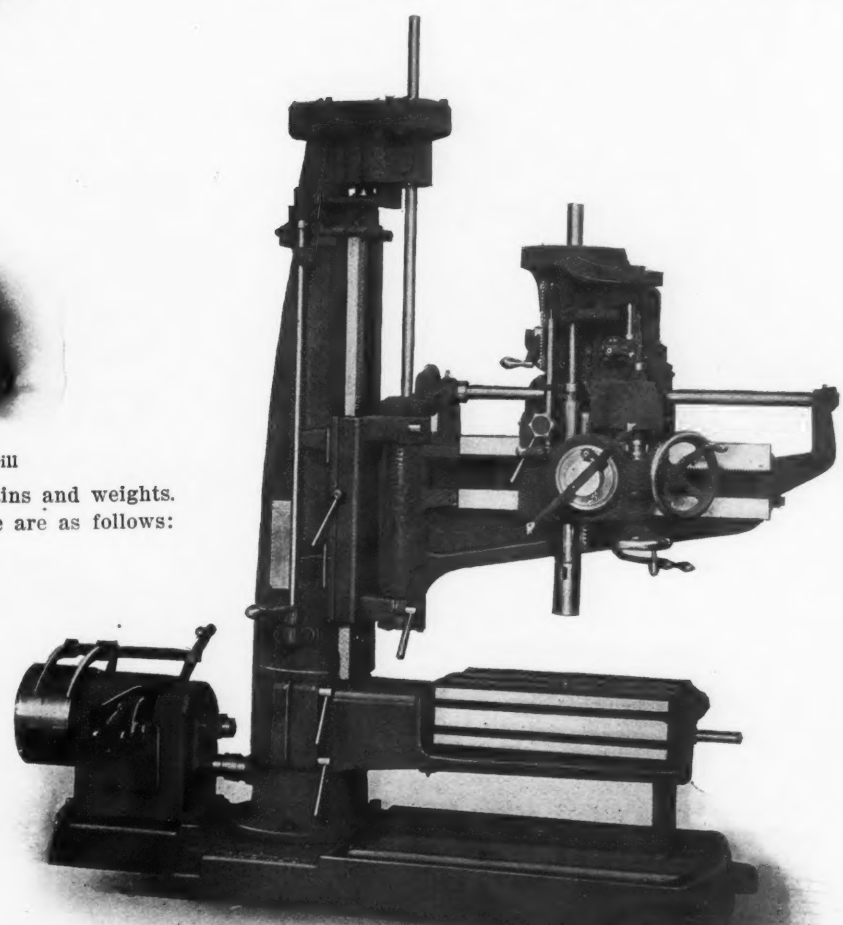
The important dimensions of this machine are as follows: Distance from column to center of spindles, 7⅛ inches; greatest distance from spindles to table, 27 inches; distance from center to center of spindles, 10 inches; vertical travel of spindles, 5½ inches; vertical adjustment of head, 9 inches; holes in spindles, No. 2 Morse taper; size of table, 12 by 20 inches; and net weight of machine 655 pounds. The capacity is for drills up to ⅝ inch in diameter. In addition to the two-spindle machine shown in the illustration, this line comprices three- and four-spindle machines.

FOSDICK HEAVY-DUTY RADIAL DRILL

The three-foot size heavy-duty radial drill illustrated herewith is the latest product of the Fosdick Machine Tool Co., Cincinnati, Ohio. With the exception of the box type of column, the arm and the table, this machine is similar in design to the round-column radial drill of the company's manufacture which was illustrated and described in the August, 1913, number of MACHINERY. This new radial drill is adapted for handling a great variety of work. Correct feeds and speeds are instantly obtainable for all sizes of drills from 5/16-inch carbon up to 3-inch high-speed steel. A complete feed and speed table is attached to the column of the machine where it may be conveniently referred to by the operator. To provide means of lubrication for heavy drilling and tapping operations in steel, an oil channel is cast around the base of the machine; this channel drains into a large reservoir under the column where a pump and piping system may be attached. For lighter drilling and tapping operations in steel, a liberal sized channel has been provided around the table; this channel drains to one corner under which a receptacle may be placed to receive the lubricant, thus avoiding the necessity of using a pump and return piping.

It has already been mentioned that the design of the column and arm are one of the new features of this machine. The column is a heavy one-piece box section internally ribbed to provide the necessary rigidity. The arm is of pipe and beam section, this form of construction having proved itself to be an exceptionally rigid combination. This design also provides for a long saddle bearing which can be securely gibbed to the wide flat face of the column, thus reducing the possibility of the arm sagging to a minimum. Means are provided for taking up any amount of wear, and the binder levers are located close to the operating position. The arm rests on a special ball bearing, which reduces the effort required to swing from one position to another, and as the pivoting point is in the saddle close to the work the movement of the arm is made very sensitive. This enables exact settings to be made very rapidly.

The elevating screw which raises and lowers the arm on



Fosdick Three-foot Heavy-duty Radial Drill

the highest speed by power is suspended from a ball bearing and the handle is placed in a convenient position for the operator. Safety trips are provided at both extremes of the movement. The tapping reverse frictions are of simple construction and afford ample power. They may be instantly adjusted for any amount of wear, this adjustment being made from the outside of the case in which the gears run in oil.

The back gears are located on the head and give three changes, any one of which is obtained by the operation of a single lever. These changes can be made without the necessity of stopping the machine. The back gears are located between the spindle and the frictions and permit the heaviest work to be handled without slipping. The bevel gears used on this machine are planed to a theoretically correct outline, and the spur gears are cut with special cutters which insure noiseless operation. The gears are of steel, and where exceptionally heavy service is encountered the gears are hardened.

The feed worm-wheel runs in oil. Five changes of feed are available, all changes being made by a single lever without requiring the machine to be stopped. The feed-box is designed to give support at both ends of the feed worm. The speed box provides six changes, any of which is obtained by the operation of a single lever which is secured by a latch to prevent chattering when the machine is engaged on the heaviest class of work. A positive over-take keeps the machine running at a reduced speed, thus avoiding shock when making speed changes. All of the gears are adequately covered and yet readily accessible. The lubrication system is very complete. Oil chambers or felt wipers are used according to the location, and the bearings are bushed with phosphor-bronze.

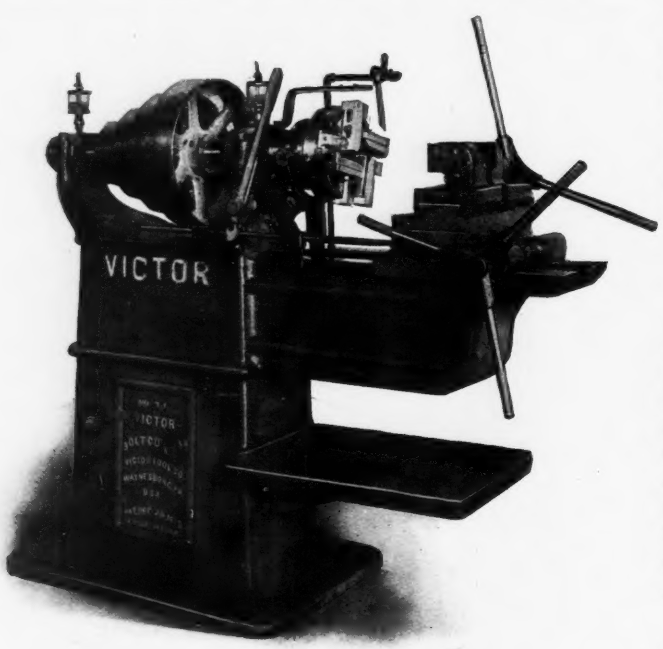


Fig. 1. Victor Bolt and Pipe Threading Machine

Motor drive may be employed on this machine at any time without requiring a special base or speed box. A constant speed or a 3 to 1 variable speed motor is suitable for this purpose, the size required being from 3 to 5 horsepower. The motor should be arranged to drive through a rawhide pinion. Although this machine is nominally a three-foot size, the maximum distance from the spindle to the column is 39 inches, and the distance from the spindle to the base is 52 inches. The net weight of the machine is 4200 pounds.

VICTOR BOLT AND PIPE THREADING MACHINE

The Victor Tool Co., Waynesboro, Pa., recently added to its line the bolt and pipe threading machine shown in Fig. 1. This machine is equipped with a patented die-head which opens and closes positively, no springs being employed. The head is equipped with an adjusting device for regulating the chasers to the required size. All four chasers are moved at the same time by means of this adjustment. When the chasers have been set to the size of the thread to be cut, the head is locked, thus holding the die to a uniform size. Each chaser holder is fitted with a set-screw at the side, by which the angle of the chasers can be regulated to suit the pitch of the thread to be cut. All adjustments can be easily and quickly made. There are no delicate or complex parts of the mechanism to get out of order and cause delay in operation.

Fig. 2 shows a side view of the die-head, illustrating how the opening and closing ring operates. The graduated adjusting screw and the locking screw are also shown in this illustration. Front and rear views of two chasers are shown, from which their design will be readily understood. The chasers are held in the holders by means of hardened screws which enable them to be quickly removed. They are hardened for their entire length and the rake can be ground to suit the various kinds of material that are being threaded. The same chaser can be used on either right- or left-hand work by using a special holder for left-hand threading operations and reversing the chaser. The chasers can be adjusted independently of each other by using the backing-up screw in the end of the holder. This die-head can be attached to any make of bolt threader.

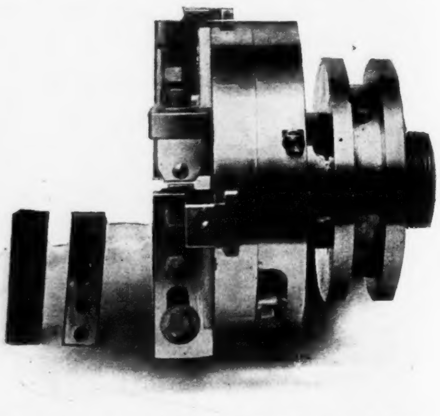
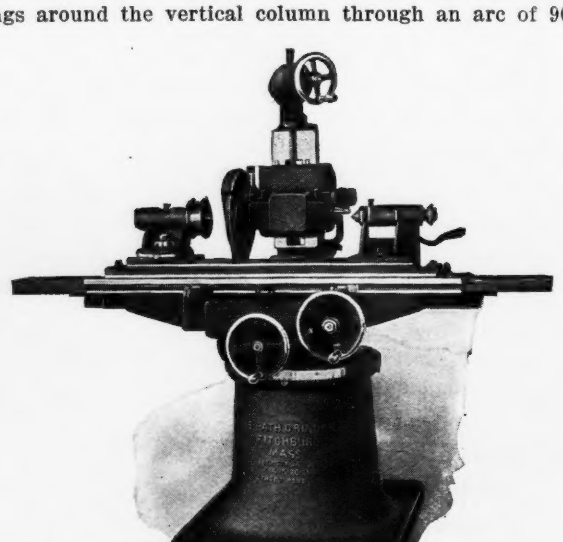


Fig. 2. Die-head used on Victor Bolt and Pipe Threading Machine

BATH CUTTER AND REAMER GRINDER

The accompanying illustration shows the No. 0 cutter and reamer grinder developed by the Bath Grinder Co., Fitchburg, Mass. The general lines are somewhat similar to those of the universal grinder of this company's manufacture, but the present machine embodies a number of distinctive features which are essential for rapid and accurate production on cylindrical, internal, surface, disk, cutter and reamer grinding. The base of the machine has the column permanently bolted to it, the column being internally ribbed to resist torsional strains. The wheel-head is gibbed to the column and has but one movement, which is vertical.

The cross-slide knee carries the cross and longitudinal slides, and has a circular base of liberal proportions. It swings around the vertical column through an arc of 90 degrees so that the work-table may be brought to the required position for the various grinding operations for which this machine is adapted. The cross-slide is substantially ribbed and of liberal dimensions. The ways are scraped to master plates and thoroughly protected from water and grit. The table is provided with a swivel-plate for grinding taper work.



Bath Cutter and Reamer Grinder

and has a scale graduated to indicate tapers in inches per foot. The headstock has a swivel base graduated to 180 degrees, and dead and live centers may be used.

The wheel-head is of rigid construction, the wheel spindle being hardened and ground. The spindle runs in adjustable phosphor-bronze boxes which are thoroughly protected from grit. The handwheel which feeds the wheel-head vertically is graduated to 0.001 inch, and is provided with a positive stop. This handwheel can be readily operated from either the front or side of the machine. The table is operated by hand and equipped with slow and fast travel. Positive stops are provided for both longitudinal and cross feeds, the cross feed handwheel being graduated to 0.001 inch. Water may be used on all operations for which this machine is adapted. The machine is of massive construction and the full universal feature adapts it for grinding large inserted tooth milling cutters up to 20 inches in diameter.

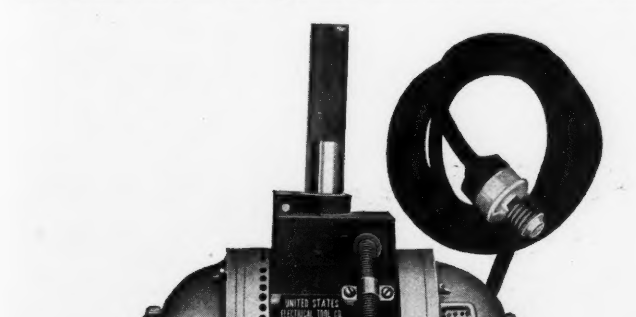
The principal dimensions of the machine are as follows: length between centers, 20 inches; swing, 10 inches; normal range for surface grinding, 9 inches wide by 15 inches long by 5½ inches high; normal range for disk grinding, 10 inches in diameter by 2 inches thick. The vertical movement of the grinding wheel head is 7 inches, and the swivel-plate is graduated to provide for grinding tapers up to 3 inches per foot. The net weight of the machine is about 2100 pounds.

Special attachments which can be obtained for use in connection with this grinder are a water attachment, a radius attachment, an internal grinding attachment and a gear-cutter attachment. The equipment includes a universal work-holder and flange plate, a horizontal vise, a 5-inch four-jaw chuck, a faceplate and draw-in collet, a combined spring and center-rest and countershafts. The following accessories are made for use in connection with this grinder: High and low tooth rests, a diamond stand, two swivel plate clamps, two grinder dogs, three wheel collets, a wheel hood and a wheel flange. The machine may be obtained with full or partial equipment, as desired.

UNITED STATES UNIVERSAL DRILL

The important feature of the portable electric drill illustrated in this connection is that the motor is applicable for use on either 110 volt direct current or 110 volt alternating current of 25, 30, 40 or 60 cycles, single phase. This type of motor was designed by the Westinghouse Electric & Mfg. Co. for use in connection with these drills, the motors being of the series wound type and air cooled.

The gears used in this portable drill are made of chrome-



United States Universal Electric Drill for Use on Alternating or Direct Current

nickel steel; they are hardened and run in grease. The spindle bearings also run in grease. The electric switch is simple in design and construction and is capable of standing up under hard service. This type of electric drill is adapted for either metal drilling or wood boring. Drills of this type are made in three sizes having capacities of ⅜ inch, ½ inch and ⅞ inch by the United States Electrical Tool Co., 6th Ave. and Mount Hope St., Cincinnati, Ohio.

BAKER HIGH-SPEED DRILL

Baker Brothers, Toledo, Ohio, have recently added to their line of drilling machines the No. 1-B high-speed ball bearing drill shown in Fig. 1. One of the characteristic features of this machine is the arrangement of the drive; this is effected through hardened steel gears mounted on shafts which run in ball bearings. Six speed changes are obtainable through the arrangement of sliding gears shown in Fig. 2. For a driving pulley speed of 500 revolutions per minute, the

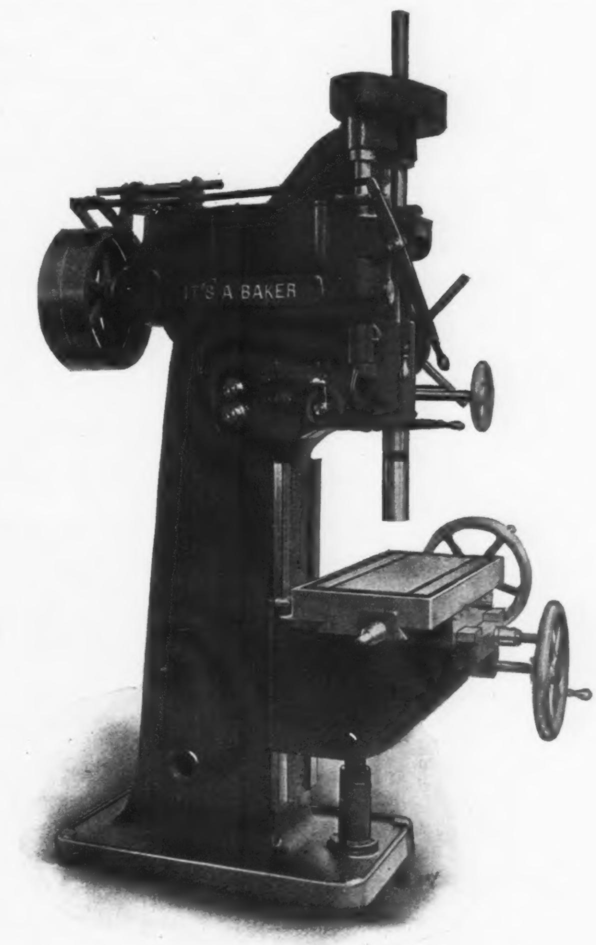


Fig. 1. Baker No. 1-B High-speed Drill

spindle speeds are as follows: 500, 369, 258, 179, 130 and 92.5 revolutions per minute. This corresponds as nearly as possible with the proposed "chromatic scale" of speeds which is advocated by some of the well-known efficiency engineers. It will be noticed by referring to Fig. 2 that with any of the six speed changes, only one pair of gears is in mesh. This not only increases the efficiency of the machine, but also adds to its durability. The latter is a particularly essential feature, as drilling machines experience very rough treatment at the hands of the average drill press operator. The gears are shifted by three parallel rods, the gear shifting lever sliding across an H-plate, giving positive interlocking and at the same time a smooth quick change.

The spindle is made from a high carbon steel forging and the thrust is effectively taken by ball bearings. The diameter of the spindle at the driving end is 2 inches, and the diameter in the quill 2⅛ inches. It is bored No. 5 Morse taper. The spindle has a vertical feed of 16 inches, and is equipped with a depth stop. Twelve changes of feed are obtainable, these changes being as follows: 0.006, 0.007, 0.008, 0.010, 0.012, 0.013, 0.015, 0.017, 0.020, 0.024, 0.028 and 0.032 inch per revolution of the spindle. These changes are obtainable by means of a powerful drive key and quick change slip gears. A safety device on the spindle feed shaft is provided to protect the mechanism from injury, and to provide uniform wear on the large worm-gear.

Machines of this type are equipped with either a plain or a compound table. The size of the plain table used is 24 by 29 inches over-all, and 17 by 23 inches inside the oil

grooves. The table is elevated by a screw. The compound table has screw adjustments in all directions and micrometer collars are provided for making accurate in-an-out and cross movements. With the screw adjustments it is not necessary to lock the table in position after adjustments have been made. The over-all size of the compound table is 16 by 30 inches. By way of conclusion, it may be mentioned that drilling machines of this type are equipped for either parallel drive, as shown in Fig. 1, or for the right-angle drive illustrated in Fig. 2.

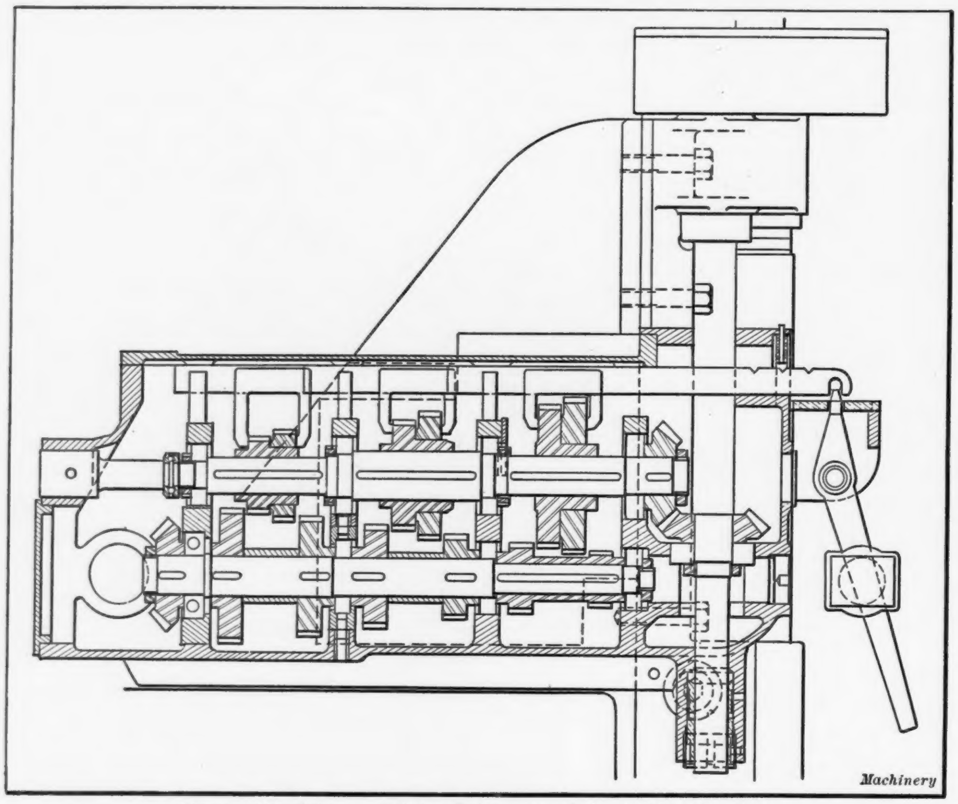


Fig. 2. Speed Box on Baker Drill arranged for Right-angle Drive

MILWAUKEE WALL TYPE RADIAL DRILL

The accompanying illustration shows the Milwaukee wall type radial drill which is a recent product of the J. C. Busch Co., Lake and Ferry Sts., Milwaukee, Wis. The Vulcan Engineering Sales Co., 2059 Elston Ave., Chicago, Ill., is the sales agent. This drill was designed to meet the requirements of bridge and structural shops and numerous other factories where large surface areas are to be covered for drilling, reaming or countersinking. In working out the design it has been borne in mind that the average machine in such shops receives very hard usage and correspondingly slight attention. To produce a drill that would stand up under such service, the construction has been made exceptionally rigid. All gears are cut from solid blanks and all bearings are bronze bushed, thus reducing friction iosses to a minimum.

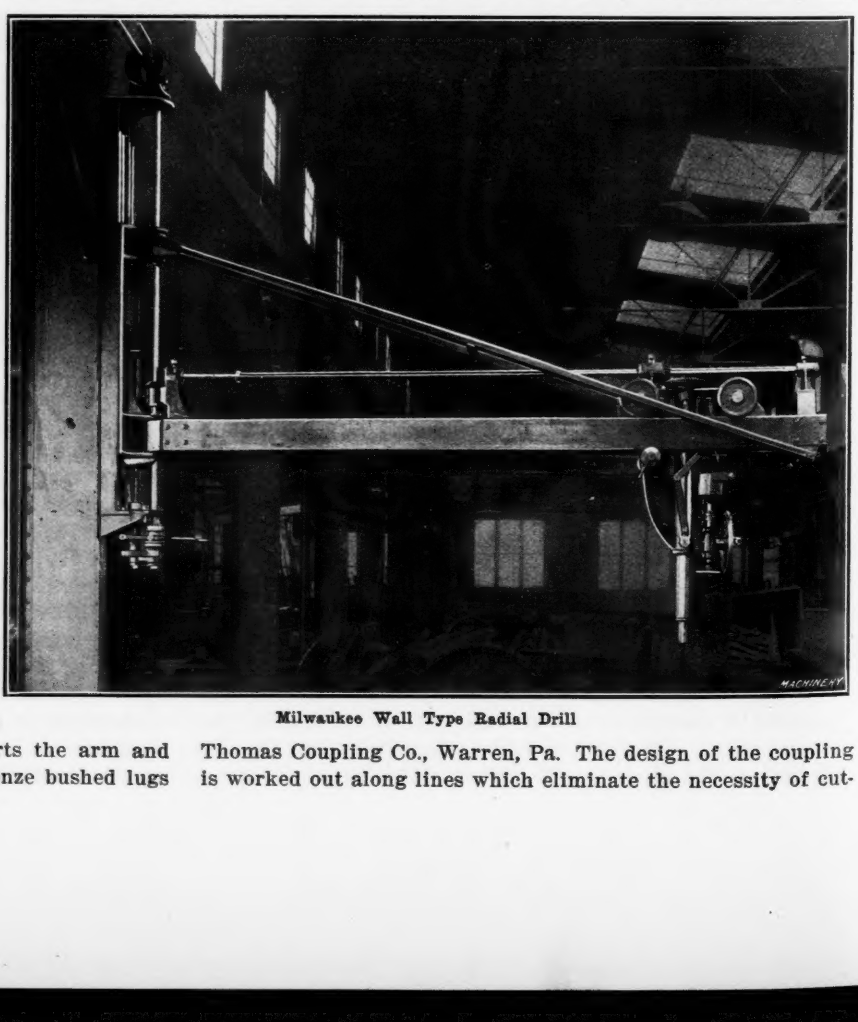
The machine can either be bolted to a building column or to the wall, or it may be carried on a truck in order to obtain the advantage of a portable tool. A stud is furnished at the end of the arm to afford a means of anchoring the arm to the floor when the machine is engaged in drilling holes of large diameter. Power is obtained by coupling a countershaft to the upper horizontal friction-clutch shaft. The wall plate is a heavy casting with machined ways to guide the elevating carriage which supports the arm and stay-bars. This carriage is provided with bronze bushed lugs by which the vertical shaft is carried. Cupped bronze frictions engaging with spur gears operate the screw shaft for actuating the carriage. Ball bearings take the vertical thrust.

The spindle carriage is a heavily ribbed casting and the wheels on which the carriage runs are carried by roller bearings. Provision is made for locking the carriage in position when drilling and reaming. A substantial sleeve ground to fit the bore in the carriage frame is fitted with ball bearings to receive the end-thrust. The large bevel gear guides and drives the upper end of the spindle. The changes of power feed are obtained through an arrangement of four sets of change gears which operate in connection with a worm-gear and friction clutch. The hand feed is operated by a handwheel which also constitutes the quick return device that is brought into action when the power feed is disengaged. A counterweight automatically raises the spindle when the hand feed is released. All levers and handwheels are located within easy reach of the operator, making the machine easy to control without requiring the attention of more than one man.

The principal dimensions are as follows: The spindle is bored No. 4 Morse taper, and the available spindle feed is 15 inches. The minimum distance from the wall to the spindle is 3 feet, and the spindle carriage has a horizontal traverse of 10 feet, 9 inches. The vertical traverse of the arm is 3 feet, 6 inches, and the arm can be swung through an angle of 180 degrees. The four available feed changes are 0.008, 0.016, 0.030 and 0.069 inch per revolution of the spindle. The weight of the machine is approximately 5000 pounds.

THOMAS SHAFT COUPLING

The accompanying illustrations show two styles of the "Little Giant" shaft coupling which are manufactured by the Thomas Coupling Co., Warren, Pa. The design of the coupling is worked out along lines which eliminate the necessity of cut-



Milwaukee Wall Type Radial Drill

ting keyways in the shafts before they are mounted in the coupling, the keyways in this case being cut by the keys which constitute a part of the coupling. Figs. 1 and 2 illustrate a coupling designed for shafts from 1 3/16 inch to 2 15/16 inches in diameter, and Fig. 3 shows a coupling for shafts ranging from 3 to 6 inches in diameter.

It will be seen from the illustrations that this coupling consists of a round iron or steel casting through which a

Fig. 1. The Thomas Self-seating and Self-keying Shaft Coupling

longitudinal hole is bored to receive the ends of the two shafts which are to be coupled together. A clearance space is also milled through the body of the coupling in a lengthwise direction, this clearance space being shown at *A* in

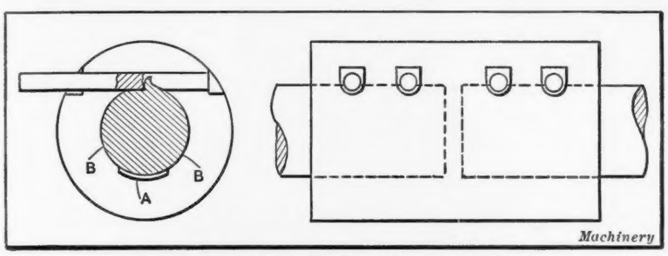


Fig. 2. Details of Coupling shown in Fig. 1

Figs. 2 and 3. The keyways are accurately located and drilled, as shown in the illustrations, so that a portion of the key enters the bore of the coupling. Special heat-treated tool steel pins or keys with cupped ends are driven into the coupling after the shafts have been entered to the desired positions. These keys are driven in by an ordinary hammer and cut away a portion of the shaft which extends above the keyways, the action of the key in cutting away the shaft being illustrated in the end view, Fig. 2. In this way the shaft is securely held against either rotary or longitudinal movement.

Referring again to the clearance space *A* shown in the end views, Figs. 2 and 3, it will be seen that there is a double bearing surface for the entire length of the coupling, these bearing surfaces being shown at *B*. In this way a wedging action is produced and the resistance offered at the surfaces *B* is always proportional to the power which the shaft is transmitting. A feature of this coupling is the entire absence of set-screws, bolt heads or other projections which are likely

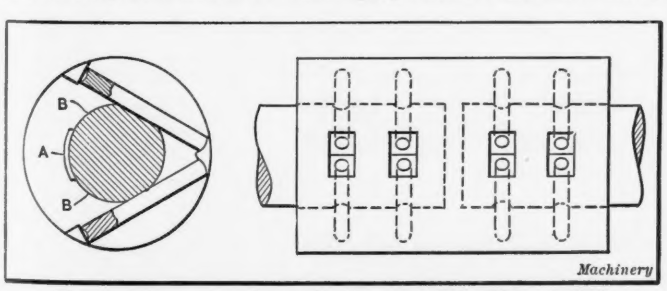


Fig. 3. Thomas Coupling with Keys on Both Sides of Shaft

to catch the clothing of men who are engaged in attending to the shafting in a factory.

FULLER TOOL-HOLDER

The tool-holder shown in Figs. 1, 2 and 3 has recently been developed and placed on the market by S. S. Fuller, 59 Wordsworth St., East Boston, Mass. This holder was designed with the idea of eliminating the breakage of cutters and set-screws which occurs when using tool-holders where the cutter is held in place by a set-screw. The features of the Fuller tool-holder are its simplicity and the flat clamping effect on the cutter. Fig. 1 shows a tool-holder open, in position to receive the cutter, while Fig. 2 shows a holder with the cutter clamped in position ready for use. The principle upon which this holder operates will be better understood by referring to Fig. 3, where it will be seen that the holder consists of two parts—the shank *A* and the movable block *B*. End stops *C* and *D* are provided on the shank, which limit the movement of the block *B*. The seat *E* upon which the block *B* slides is at an angle to the cutter seat *F*, and when the block slides in the direction of the stop *C*, the cutter seat

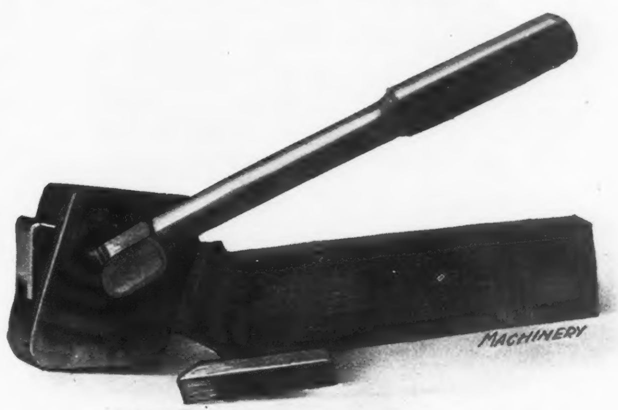


Fig. 1. Fuller Tool-holder in Position to receive Cutter

G in the block moves toward the seat on the shank of the tool-holder. This causes the cutter to be clamped between the seats *F* and *G*, the pressure being applied over a flat surface which eliminates the danger of breaking the cutter through concentrating the pressure at a single point.

The clamping block *B* is operated by a removable key which is shown in the operating position in Fig. 1. This key has a cam which engages the sides *H* and *J* of a recess in the clamping block when the key is rotated about a pivot fitting in the hole *K* in the shank of the tool-holder. In this way the cutter can be tightened in or released from the tool-

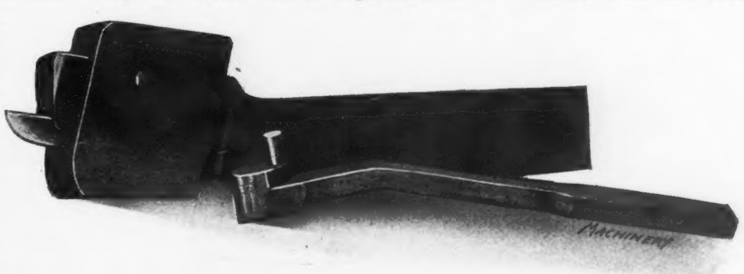


Fig. 2. Fuller Tool-holder with Cutter in Place ready for Use

holder as desired. The key may be used on either side of the tool-holder, and in the event of its becoming lost, the clamping block may be manipulated by tapping it with a soft metal

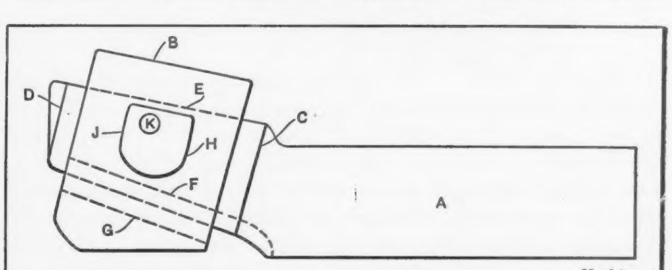


Fig. 3. Principle upon which the Fuller Tool-holder operates

hammer. Another feature of this tool-holder is the self-wedging effect which results from the pressure of the cutter against the work. This pressure tends to clamp the cutter more firmly as the feed is increased, so that the security with which the cutter is held is proportional to the severity of the service.

HORVATH INTERMITTENT MOVEMENT

The accompanying illustrations show a spiral cam and roll plate which was designed by the Horvath Mfg. Co., 190 Hague Ave., Detroit, Mich., to transmit an intermittent motion to a dial. This movement was designed for use on a high-speed automatic machine which required very accurate indexing and locking of a dial at each 1/8 revolution. The Geneva or other intermittent movement could not be used on account of the high speed at which the machine was to be operated, but the cam and roll plate arrangement which forms the subject of this article proves very successful at a speed of 350 revolutions per minute. It operates without shock or

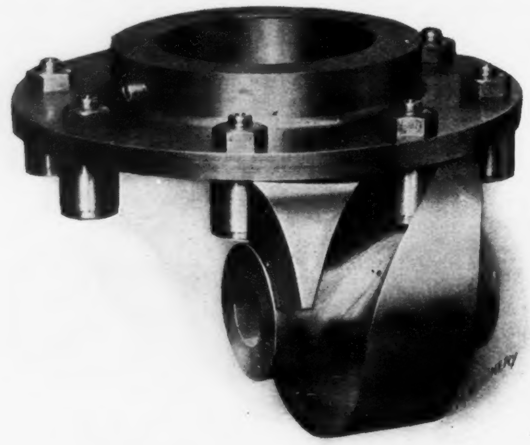


Fig. 1. Horvath Intermittent Movement in the Operating Position

vibration and is noiseless, the curve of the cam being so designed that it starts the dial slowly, then accelerates the speed at the middle of the movement and gradually slows it down again before coming to rest. There is positively no lost motion of the dial in any position.

The operation of this intermittent movement is as follows: The spiral cam, which is the driver, has spiral grooves cut in it, the length and curve of these grooves determining

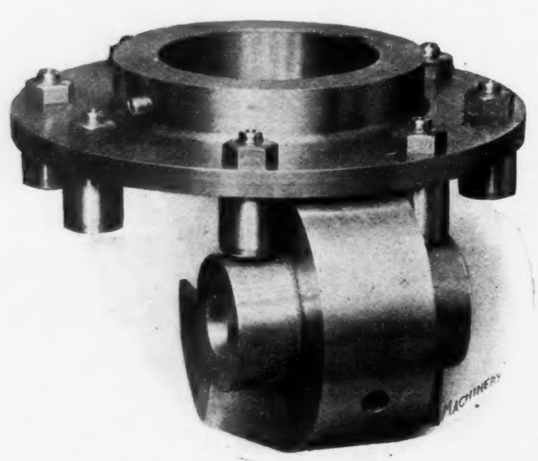


Fig. 2. Horvath Intermittent Movement locked during the Period of Rest

the time required to turn the dial and the period of rest between movements. This relation can be varied to obtain any desired result. The cam groove engages a roll on the plate and revolves it through the required part of a revolution. Any number of stops can be made according to the spacing and number of rolls. The part of the machine to receive the intermittent motion is fastened to the same shaft as the roll plate. As previously stated, the cam and roll plate could be designed to transmit any kind of intermittent motion that was desired. The advantages of this movement may be briefly summarized as follows: The dial is positively locked in every position; any desired period of rest or motion can be obtained; the movement is noiseless at high speed; and as it is of compact form, it occupies very little space. The Horvath Mfg. Co. is prepared to make this type of intermittent movement to meet various requirements.

FAFNIR BALL BEARING BOX

The Fafnir double ball bearing box, illustrated herewith, is a product of the Fafnir Bearing Co., New Britain, Conn. This box was designed to replace plain bearings on existing installations of lineshafting, the substitution being easily accomplished with little loss of time. The dimensions of the casting are such that the ball bearing box may be installed in any standard type of shaft hanger; consequently it is unnecessary to tear down the complete line of shafting, as the substitution of ball bearings for plain bearings may be accomplished by simply removing the coupling and possibly a pulley on each section of the shafting. The ball bearing box is then slipped onto the shaft.

Fig. 2 shows a cross-sectional view of the Fafnir bearing box, from which the construction will be readily understood. The sleeve is an integral part of the two bearings, having a ball raceway ground at each end. The outer rings of the

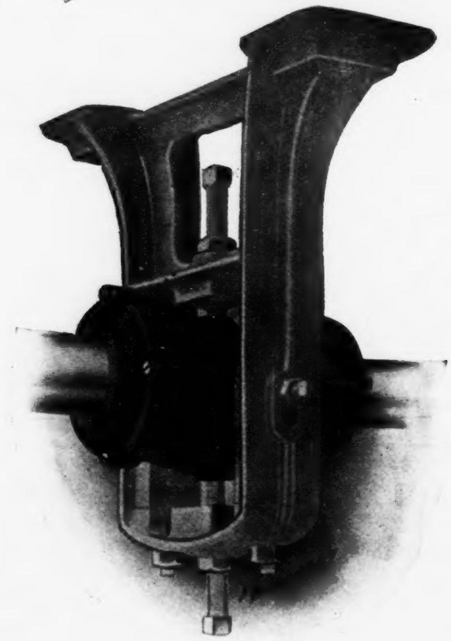


Fig. 1. The Fafnir Ball Bearing Box for Lineshaft Hangers

bearings are held in the box casting, the box being supported in the hanger frame by means of two vertical adjusting screws fitting into cups placed on the casting for this purpose. Where a hanger frame is also provided with side adjusting screws, bearings for the screws are provided by lugs on each side of the casting. As a matter of fact, the top and bottom adjusting screws afford ample support, the side adjustment being unnecessary. The sleeve is a tight slip fit and revolves with the shafting. The two end caps are furnished with grooves which become filled with grease when the bearing is first charged with lubricant, and afford an effective frictionless seal which excludes dust or moisture. Another feature

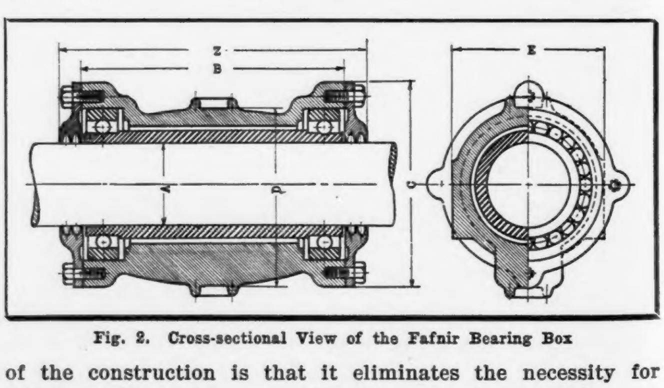


Fig. 2. Cross-sectional View of the Fafnir Bearing Box

of the construction is that it eliminates the necessity for adapters, slip bushings or adjusting nuts of any kind.

The bearings are made of high-grade alloy steel of a special composition that has been found particularly well suited for ball bearings. The rings are subjected to a special heat-treatment, and then ground and polished with the greatest

care. The balls are perfectly spherical and accurate to within 0.0001 inch. The complete bearing operates without noise and is practically frictionless. The manufacturers claim that the substitution of this type of bearing in place of plain bearings effects a reduction of friction losses on the line-shaft ranging from 25 to 60 per cent, and even as high as 75 per cent in certain cases. These figures apply when the shafting is running either idle or loaded. The bearings are charged with non-fluid oil and it is not necessary to replenish this lubricant oftener than once a year. It will be evident from this that the use of these ball bearings also effects a material saving in the cost of shafting maintenance.

HUTHER INSERTED-TOOTH MILLING SAW

Huther Brothers Saw Mfg. Co., 1108 University Ave., Rochester, N. Y., has recently added to its line the inserted-tooth type of milling saw shown in the accompanying illustration. The body of this saw is made of two crucible steel plates which are spring tempered and firmly riveted together. The inserted teeth are made of high-speed steel and they are so formed that sharpening is done only at the front of the teeth. A set of inserts adds about three inches to the diameter of the saw. The construction has been worked out along lines to combine strength and thinness. The latter is a particularly important feature where the saw is engaged in cutting expensive stock, as the saving of material is an important factor. The inserted tooth feature makes it possible to replace worn or damaged teeth at a slight expense.

The manufacturers recommend driving these saws to give a peripheral speed of 60 feet per minute. When operated at this speed the saw can be advanced at the rate of two or three inches per minute according to the capacity of the machine. Saws of this type are made in a variety of different sizes. The thickness of the teeth for saws of various diameters is as follows: For a 14-inch saw, 3/16 inch; for an 18-inch saw, 7/32 inch; for a 26-inch saw, ¼ inch; for a 30-inch saw, 9/32 inch; for a 40-inch saw, 5/16 inch; and for a 60-inch saw, ⅜ inch. The thinness of these saws enables them to cut faster and effect a saving in power and material.

Huther Inserted-tooth Milling Saw

GERSTNER TOOL CASE

The accompanying illustration shows a new design of portable tool case which has been brought out by H. Gerstner & Sons, 15-23 Columbia St., Dayton, Ohio. It is known as Style No. 41, and is made in three different sizes to meet different requirements. A convenient set of drawers affords a place for the tools, which are instantly accessible and adequately protected from damage. The top compartment of the case affords space for the larger and more bulky tools.

This case is neatly finished and of light weight, although it is quite substantial and capable of giving good service. The handle, which is similar to that of a suit case, is fastened to the top and enables this tool case to be conveniently carried from one job to another. To close the case, the front lid is pulled out from under the bottom drawer; this lid is mounted on hinges and is swung up at the same time that the top lid is lowered. The case is provided with a lock.

The drawers have felt-lined metal bottoms and the fronts of the drawers are finished in quartered oak. The outside of the case is covered with black imitation seal grain leather which is very serviceable and gives the case a neat appearance. The top compartment is felt-lined throughout, and the metal trimmings used on the case are of either polished or nickel plated brass.

No. 41. Gerstner Tool Case

ATHOL VISE TAPER ATTACHMENT

Toolmakers frequently find it necessary to hold tapered pieces of work in a vise and for this purpose vises are made with a swiveling jaw. Figs. 1 and 2 show two simple attachments which can be used on an ordinary vise to adapt it for holding tapered work. In this way the plain vise is made to serve in place of the more expensive vise equipped with a swiveling jaw. These attachments are a recent product of the Athol Machine Co., Athol, Mass.

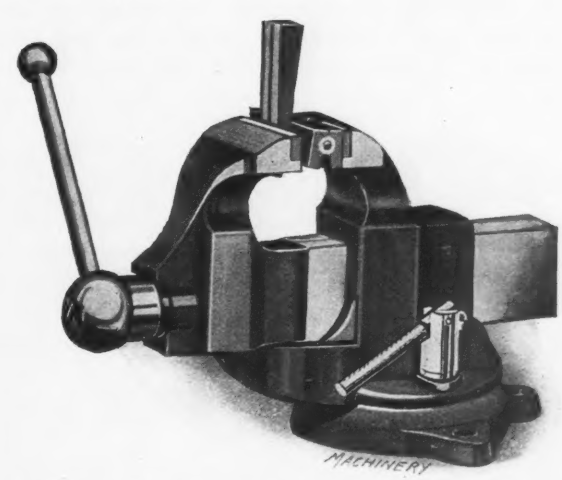


Fig. 1. Athol Vise Attachment for holding Tapered Work in a Vertical Position

Fig. 1 shows the attachment used for holding tapered work in a vertical position. Referring to this illustration it will be seen that the attachment consists of two blocks which are secured to each other by a horizontal pivot. One of these blocks is secured to the stationary jaw of the vise while the other swings on the pivot to adjust its position for the required taper angle of the work.

Fig. 2 shows the attachment for holding a tapered piece in a horizontal position. It will be seen that this attachment consists of a block which is held to the fixed jaw of the vise. This block has two small blocks secured to it by vertical pivots. When the vise is tightened on the tapered piece, these two blocks adjust themselves to the required angle.

This attachment is particularly useful for holding short pieces of tapered work. It will be seen that these two attachments are shown mounted on the Athol swivel base vise

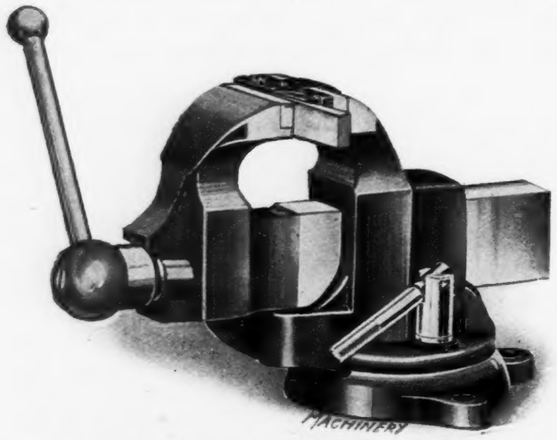


Fig. 2. Vise Attachment for holding Tapered Work in a Horizontal Position

which was illustrated and described in the April, 1913, number of MACHINERY.

SCHUCHARDT & SCHUTTE PROFILE MILLING MACHINE

Schuchardt & Schutte, Cedar and West Sts., New York City, are now building the duplex automatic profile milling machine shown in Fig. 1. This machine is adapted for handling any form of work within its range that can be held on the end of a revolving spindle. It will be seen from the illustration that the machine is equipped with duplex heads, and this feature, in connection with the automatic feeds and trips with which the machine is provided, gives a high rate of production and a corresponding reduction of manufacturing costs. The cutter spindles are belted to the countershaft which is driven at 240 revolutions per minute, except when the machine is engaged in profiling brass parts, in which case the countershaft speed recommended by the manufacturers of the machine is 360 revolutions per minute. These figures are by no means exact, and in many cases it will be found desirable to depart from them. The cutter spindle is hardened and runs in adjustable bearings, the end thrust being taken on a hardened pin which runs in oil. Spiral

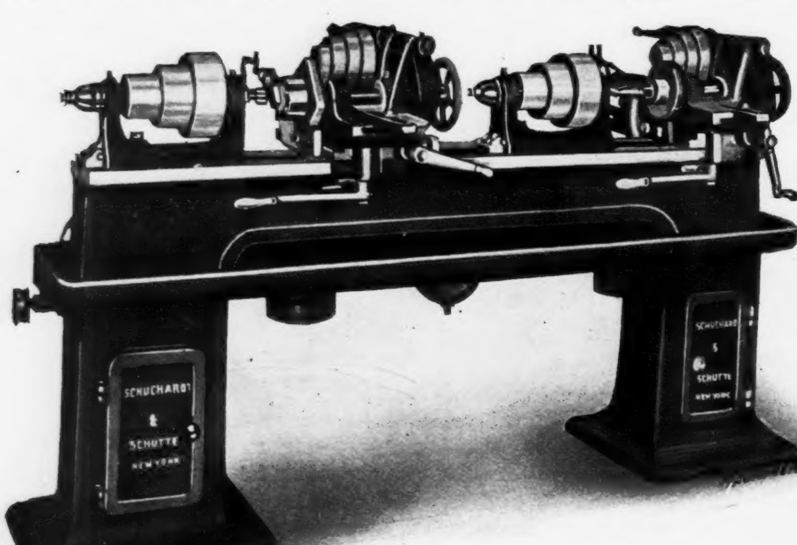


Fig. 1. Schuchardt & Schutte Duplex Automatic Profile Milling Machine

cutters are used which are inexpensive to make and to maintain.

The work is mounted on the ends of spindles carried by the duplex heads of the machine. These heads are supported on cross-slides with adjustable bearings and are moved in and out by means of the master-cams or "copy-plates" which are held in contact with the rollers by weights at the back of the machine. The feed motion which revolves the work against the cutter is driven from the countershaft by means

RATE OF PRODUCTION ON WORK SHOWN IN FIG. 2

Mark	Description	Material	Output	
			Pieces per Hr.	No. of Cuts
A	Pinion cam for motor cycle	Steel	15	2
B	Cam for gas or oil engine	Cast iron	15-30	2-1
C	Valve rod bushing	Gun metal	50	1
D	Ball bearing cup	Steel	50	1
E	Trigger-guard for rifle	Steel	4	2
F	Nut for wheel cap	Gun metal	6	2
G	Hexagon nut	Steel	15	2
H	Cam for gas engine	Steel	15	2
I	Gland for gas engine	Gun metal	30	1
J	Ball-head lug for bicycle	Steel	50-60	Either operation
K	Connecting-rod end	Steel	30	1

Machinery

of a cone pulley and worm-gearing. Automatic feed trips are provided which can be set to stop the feed at any point

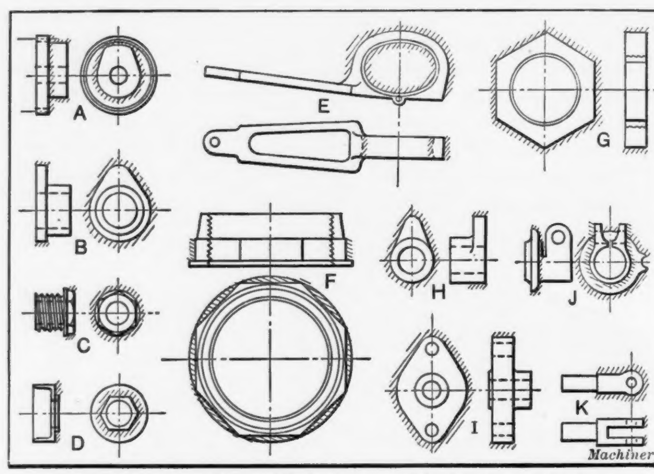


Fig. 2. Examples of Work done on Schuchardt & Schutte Profile Miller

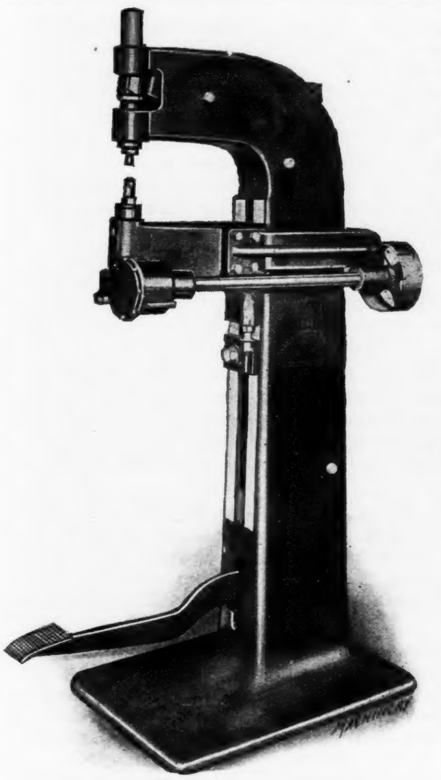
in the revolution. In cases where it is desired to take a second or finishing cut, the trip can be set to operate at the end of the second revolution. Relief clutches are provided on the worm-wheels which enable irregular profiles to be milled that could not be handled by other means. Fig. 2 shows examples of profile milling done on this machine and the table gives the rate of production for each piece.

The saddles have a short movement along the bed to provide for withdrawing internal work from the cutters. The brackets upon which the rollers are mounted which run in contact with the copy-plates are secured to the saddles. The copy-plates are milled on the machine. In arranging the machine for milling the profile of any given piece, the first step is to make a model. This model is then used to control the movement of the machine in milling the master cams or so-called "copy-plates." The copy-plates produced in this way are then used for controlling the machine in profiling subsequent pieces. Each of the duplex heads on this machine is independent of the other so that the two heads can be engaged on different classes of work if such a procedure is desirable. The bed of the machine is of rigid construction and is surrounded by an oil tray equipped with a reservoir and strainer. All of the gears are cut from solid blanks, and all gearing is carefully enclosed to provide for the safety of the operator. The equipment regularly provided comprises two counter-

shafts, master plates, cutters, oil pumps and connections, one copy generating attachment and two cutters.

GRANT RIVETING MACHINE

The riveting machine shown in the accompanying illustration is a recent product of the Grant Mfg. & Machine Co., 80 Silliman Ave., Bridgeport, Conn. This machine represents a departure from the preceding designs which have been brought out by this company in



Grant Rivet Spinning Machine with Rollers on Lower Side

that the riveting is accomplished in a reverse position from that of the regular rivet spinning machines. It will be noted that the riveting rollers are located on the under side instead of at the top, which is the usual practice. This machine was designed for operating on the inside of circular work such as electric light fixtures and a variety of similar articles. The riveting spindle is driven by helical gears which run in an oil-tight case and can be packed with grease or other lubricant. Power is supplied to the machine through a pulley at the rear. Means of adjustment are provided on the countershaft for maintaining a uniform tension on the belt when the table is raised or lowered for work of various thicknesses, thus insuring an efficient transmission of power at all times. The illustration makes the construction and method of operating the machine quite clear.

NEWTON CYLINDER BORING MACHINE

The Newton Machine Tool Works, Inc., Philadelphia, Pa., has recently built two large boring mills for machining modern locomotive cylinders, in which the circular valve chamber is bored from the solid cylinder casting. The machine is fitted with a compound table having transverse, longitudinal and vertical adjustment. This enables the circular valve chamber to be bored first, after which the cylinder is bored. While the cylinder is being bored the valve chamber bushing can be fitted, and the final operation then consists of boring this bushing. The adjustments provided by the compound table enable all of these operations to be handled without disturbing the location of the work, and this elimination of the necessity for resetting is the means of effecting a material saving of time. The spindle is 7 inches in diameter

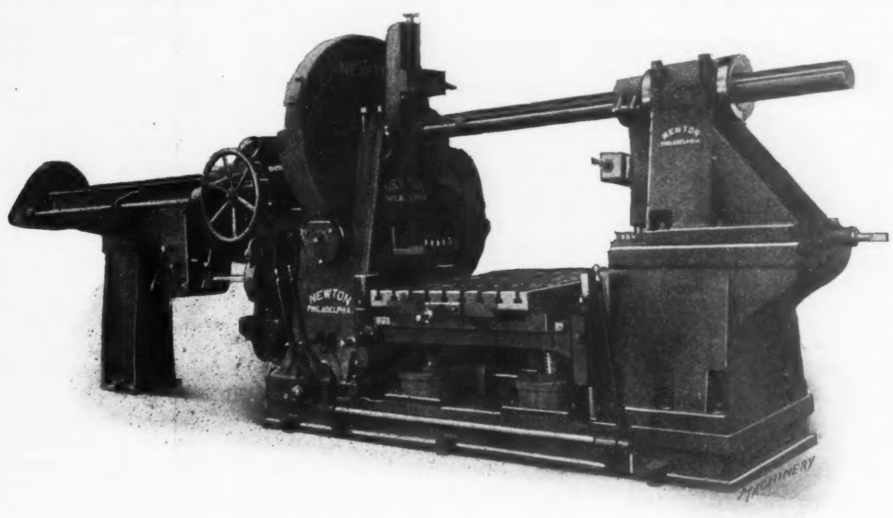


Fig. 1. Front View of Newton Locomotive Cylinder Boring Machine

and has a continuous travel of 140 inches. There are six changes of geared feed and rapid power traverse in both directions. The capacity of the machine is to bore and finish both ends of cylinders up to 50 inches in length. The cross adjusting table is 54 inches in width by 72 inches long, and the vertical adjustment gives a range of from 39 to 51 inches from the top of the table to the center of the spindle. The maximum distance between the facing arms is 60 inches.

The main drive for the spindle is through a steep lead worm-wheel which engages a hardened steel worm fitted with roller thrust bearings. The worm and worm-wheel are encased and run in oil. The drive is so arranged that the fast power traverse of the spindle may be used while the spindle is not rotating, and this fast power traverse, the rotation of the spindle, and the power elevation of the table

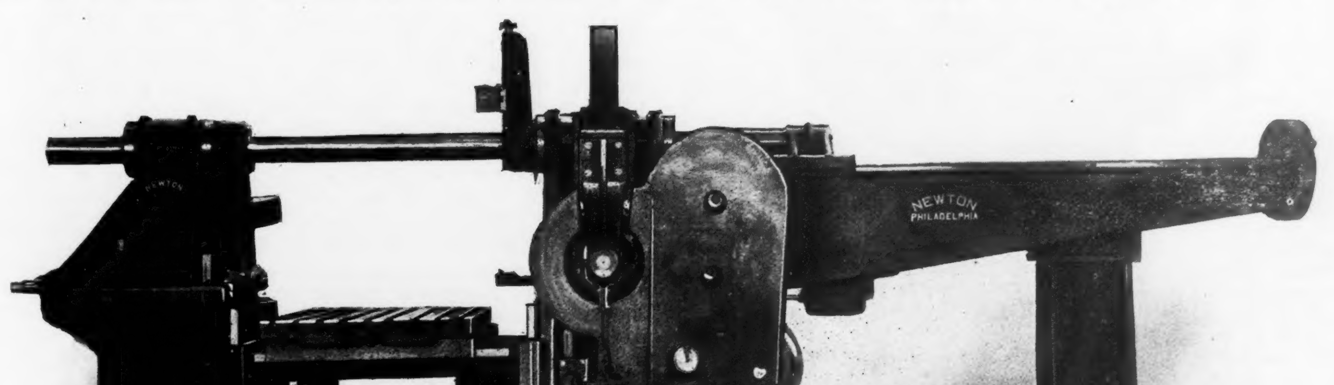


Fig. 2. Opposite Side of Boring Machine shown in Fig. 1

may be disengaged or engaged by levers located at the operating side of the machine beside the main head without stopping the motor. The feed is taken from the gear-box, having eight gears mounted on sliding sleeves. Six feed changes are available without requiring the removal of gears, and the sleeves are easily adjusted by means of latch levers.

The saddle has roller bearings to take the thrust in both directions. The outboard bearing is provided with independent in and out adjustment so that the cylinders may be mounted on the main table and adjusted to come within the range of the facing head on the main spindle sleeve. The outboard bearing can then be adjusted to bring the dependent facing head within range of the adjacent spindle flange. It will be noticed that the facing heads are provided with an eccentric clamp permitting the spindle sleeves to be rotated while the facing heads hang idle.

VALLEY CITY WHEEL-GUARD

The illustrations show a new adjustable wheel-guard which the Valley City Machine Works, 12-16 Campau Ave., Grand Rapids, Mich., has added to its line of grinding equipments. While primarily developed for use in connection with Valley City grinders, this hood is applicable for use in connection with any type of emery wheel stand. An important feature is that it protects the nut on the arbor as well as the wheel.

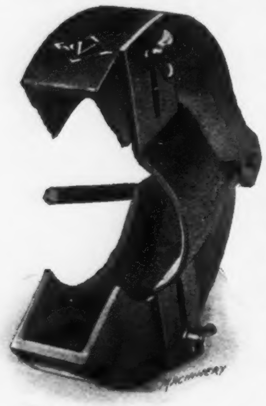


Fig. 1. Small Size of Valley City Grinding Wheel Guard

Fig. 2 shows a 24-inch guard which has been adjusted to fit over a grinding wheel 18 inches in diameter. It will be evident from this illustration that the hood has been moved back so that the face of the wheel is available; at the same time adequate protection is provided. Guards of this type are made in sizes for grinding wheels ranging from 8 to 24 inches in diameter.

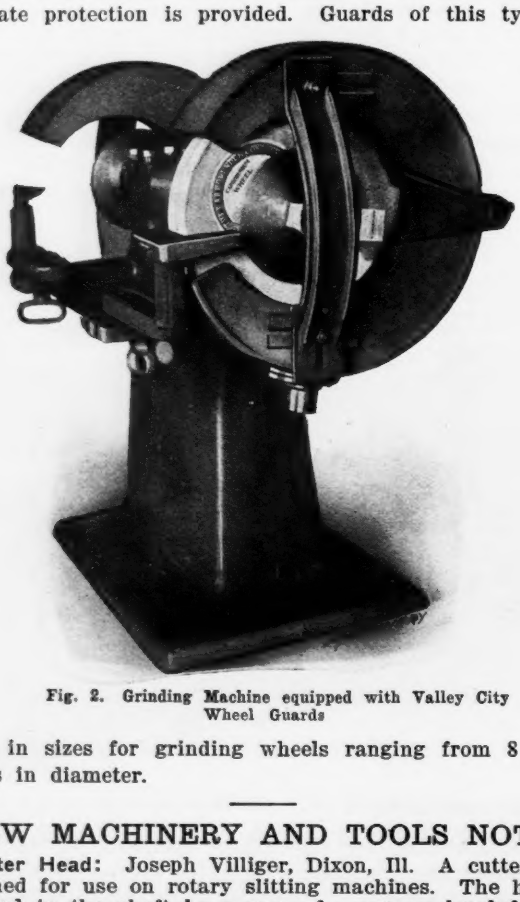


Fig. 2. Grinding Machine equipped with Valley City Wheel Guards

NEW MACHINERY AND TOOLS NOTES

Cutter Head: Joseph Villiger, Dixon, Ill. A cutter head designed for use on rotary slitting machines. The head is clamped to the shaft by means of a square headed collar screw.

Hydraulic Pump: Defiance Machine Works, Defiance, Ohio. A double plunger, hydraulic pump for use in connection with hydraulic presses where the required pressure ranges from 5 to 100 tons.

Hydraulic Press: Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mt. Gilead, Ohio. A 500 ton inverted hydraulic press intended for straightening steel castings. This press can also be used for other heavy straightening operations.

Engraving Machine: George Gorton Machine Co., Racine, Wis. A machine intended for engraving serial numbers on the oval edges of cream separator bowls. Motor drive is provided by a motor carried on a shelf secured to the standard.

Plate Joggling Machine: Hilles & Jones Co., Wilmington, Del. A machine with a capacity for handling plates ¾ inch in thickness at the rate of 10 feet per minute. The machine is driven by a 50 horsepower G. E. motor, taking current from a 220-volt direct-current circuit.

Tapping Chuck: W. L. Procunier, 208 N. 5th Ave., Chicago, Ill. A tapping chuck arranged with a safety friction drive to prevent breaking the taps. One of the features of this chuck is that there are no projecting parts, such as setscrews, which can injure the operator.

Threading Machine: Williams Tool Co., Erie, Pa. A 16-inch pipe threading and cutting-off machine which is known as the No. 6 size. This machine is adapted for the heaviest classes of work that come within its range. Pipe ranging from 7 to 16 inches in diameter can be handled.

Gages: Reed & Prince Mfg. Co., Worcester, Mass. This company has recently brought out an adjustable templet gage provided with a fitting pin to keep the gage in alignment. Other recent products are a solid templet gage for screw stock, a thread limit gage and a screw thread micrometer.

Diamond Holder: Thomson Tool & Supply Co., Indianapolis, Ind. A diamond holder for use in dressing grinding wheels. The diamond is held in place against the pressure of a spring and in case of shock the spring absorbs the excessive pressure and greatly reduces the possibility of breaking the stone.

Friction Socket Wrench: Allen Wrench & Tool Co., Providence, R. I. This wrench consists of three working parts, designed in such a way that it grips the socket head and turns it by the action of a friction drive. The wrench can be made to grip at any point and is available for use in very limited spaces.

Portable Geared Electric Hoists: Detroit Hoist & Machine Co., Detroit, Mich. A line of geared electric hoists which is quite similar to the line of pneumatic hoists made by this company with the exception of the motive power. The hoist is of simple and compact design and is said to be essentially "fool proof."

Disk Grinders: Gardner Machine Co., Beloit, Wis. Two styles of patternmaker's disk grinders. One of these machines is equipped with direct connected motor drive and is only adapted for wood-working. The other is a combination machine which can be used by patternmakers and is also suitable for grinding metal.

Pneumatic Drill: Ingersoll-Rand Co., New York City. A pneumatic drilling machine built in five sizes. A feature of this machine is that the entire motor apparatus may be assembled or taken apart through the crank case by simply removing the cover. The motor is of the angular, four-cylinder, single-acting reciprocating type.

Cylinder Boring Machine: Moline Tool Co., Moline, Ill. A multiple spindle machine equipped with a cross adjustable table to adapt it for milling ports in the cylinders of Knight engines, the design of the head being carefully worked out to secure a degree of accuracy in machining that makes a subsequent grinding operation unnecessary.

Vertical Saw: Newton Machine Tool Works, Inc., Philadelphia, Pa. A vertical spindle cold metal saw, designed for cutting off risers from relatively flat castings such as driving wheels, large gears, etc. The casting is placed on the table of the machine and bolted in place, after which the riser is cut off by feeding the work up to the saw.

Speed Regulator: Standard Engineering Works, Woonsocket, R. I. A speed regulating device where the speed variation is obtained by adjusting the relative sizes of the driving and driven pulleys. The rims of these pulleys are made in sections and provided with means for expanding or contracting them to adjust the diameters to the required sizes.

Cutter and Reamer Grinder: Matson Machine Co., Concord, N. H. A machine with a range that enables it to handle grinding operations on all types of milling tools up to 11 inches in length by 8¾ inches in diameter. Tools with either straight or spiral flutes may be sharpened and the machine is also capable of handling end mills with straight or taper shanks.

Gang Drill: Rockford Drilling Machine Co., Rockford, Ill. A vertical chucking gang drill designed for handling work requiring considerable power but where a great amount of swing is not necessary. The machine is provided with a simple type of positive geared feed providing a wide range

for boring, drilling and reaming operations. Hand feed is also available.

Screw Driver: Benjamin Electric Mfg. Co., Chicago, Ill. A friction screw driver which combines the features of an ordinary and a ratchet screw driver. The handle of the screw driver is insulated, making it particularly suitable for the use of electricians. The friction drive is obtained by a V-bearing between the two parts of which the hard rubber handle is composed.

Heat-treating Furnace: Industrial Furnace Co., 671 Atwater St., Detroit, Mich. A line of furnaces for use in the heat-treatment of high-speed steel. These furnaces are provided with an exceptionally large burner capacity to adapt them for furnishing the high temperatures required for high-speed steel treatment. The lining is particularly heavy to enable them to withstand the intense heat.

Plain Grinding Machine: Brown & Sharpe Mfg. Co., Providence, R. I. A variable speed mechanism is the chief feature of this machine. This device consists of multiple friction disks located at the rear of the machine. By adjusting two levers at the front of the machine a wide range of table feeds and work speeds is obtainable. A dial provides for setting the levers for the required speed and feed.

Boring Mill: Pratt & Whitney Co., Hartford, Conn. A boring mill equipped with a side head. With the side head in operation, the machine is capable of turning, boring or facing work up to 38 inches in diameter. With the side head lowered below the surface of the table, work up to 44 inches in diameter can be faced with the vertical turret. Both turrets are provided with independent feed and rapid traverse.

Upright Drill: W. P. Davis Machine Co., 305 St. Paul St., Rochester, N. Y. This machine has a geared feed box and dial for regulating the feed changes. There are three changes of positive geared feed ranging from 0.007 to 0.017 inch per revolution of the spindle. The dial shows at a glance the feed that is in use. The back gears on the machine are thrown in and out of engagement by the movement of a single lever.

Countersinking Machine: Chicago Pneumatic Tool Co., Chicago, Ill. This machine has been developed with the view of eliminating the necessity of employing rigging, back stops and feed-screws that were formerly necessary for drilling and countersinking holes in the flanges of channels, I-beams and similar work. This countersinking machine is intended for use in connection with the "Little Giant" drill built by this company.

Four-spindle Boring Mill: Newton Machine Tool Works, Inc., Philadelphia, Pa. Each of the four spindles of this machine is provided with individual drive. Two of the spindles are driven by 7½ horsepower G. E. motors running at 400 to 1200 R. P. M. and giving spindle speeds of 6 to 54 R. P. M. The other two spindles are driven by 5 horsepower G. E. motors running at 400 to 1200 R. P. M. and giving spindle speeds of 18 to 54 R. P. M.

Radial Drill: William Sellers & Co., Inc., Philadelphia, Pa. A high power radial drilling machine built in 60, 72, 84 and 96-inch sizes. The drilling head is designed to bring the spindle close to the face of the arm to eliminate torsional strains as far as possible. The drill head is moved on the arm through a spiral pinion and steel rack, the hand-wheel being placed directly on the head. The machine is driven by a 20 horsepower variable speed motor.

Alligator Pipe Wrench: Shaw Propeller Co., Boston, Mass. This wrench is composed of a single piece of metal and is capable of doing any work that can be handled by a Stillson-, monkey-, alligator- or flat-wrench. Work can be done rapidly with it, and a sure grip is obtained, the wrench being of ample strength for work that comes within its range. No adjustment is required to adapt the wrench for different classes of work. The grip is proportional to the effort which is required to loosen a nut or fitting, being automatically adjusted by the effort applied by the operator.

Die Casting Machine: Indiana Die Casting Development Co., Indianapolis, Ind. A semi-automatic rotary type die casting machine. A Bellevue gas-fired soft metal melting furnace is used to melt the metal, which is delivered to the machine pots as required. Sheet metal covers are provided to protect the operator from danger resulting from the liability of the metal to spurt out if the pressure is applied before the die is properly closed. The machine is of the non-plunger type. It is operated under high air pressure and the metal is drawn from the bottoms of the pots, which insures obtaining dense castings.

Boring Mill Pressure Compensator: H. D. Bennett, Baltimore, Md. A device intended for reducing frictional resistance of the table of boring mills. This compensating device was designed to eliminate the difficulty experienced in a shop where the lineshaft was driven by an engine that was occasionally subjected to severe overloads. At such times the frictional resistance of the boring mill table was sufficient to put the machine out of action. The use of this pressure compensator has proved a means of eliminating this difficulty, and it is capable of saving a considerable amount of power in the operation of boring mills.

Rack Cutting Machine: Gould & Eberhardt, Newark, N. J. A rack cutting machine designed for use on medium sized work. This machine is made up of parts of the 36 by 12 inch vertical cutter type of gear cutter built by Gould & Eberhardt. The work table is indexed automatically and while the indexing is being performed the cutter slide is locked so that it cannot feed down until the indexing has been completed. Single or gang cutters may be used and the machine may be arranged to index automatically for the number of cutters that are in use. The capacity of the machine is for racks up to 36 inches in length by 10-inch face width, and it will cut teeth of 1½ diametral pitch in cast iron or 2 diametral pitch in steel.

* * *

HIGH-SPEED DRILL USAGE

The Cleveland Twist Drill Co., Cleveland, Ohio, states that the cutting ability and hardness of drills are not the same thing, especially in high-speed drills. The apparent hardness which varies with the composition of the steel is no indication of its power to stand up under cut. A high-speed drill that cannot be filed may be made to drill extremely hard material by exercising great care, but it is so brittle as to be worthless for softer material. Numerous tests have proved that files vary in hardness quite as much as other hardened tools, and for this reason file tests are unreliable. No drill that files hard or soft should be condemned for this reason alone, but should be first given a drilling test in material of known hardness.

The recommendation is made that high-speed drills be warmed before using, especially where the conditions of service are severe. Any hard piece of steel is brittle when cold, and high-speed drills are no exception. They work better when warm, often giving good results when the chips are turned blue by the heat generated. Never turn cold water onto a high-speed drill, as it is very likely to crack. It is also bad practice to plunge a drill into cold water after the point has been heated in grinding. The drill may be impaired by starting a number of fine cracks in the point.

The following lubricants are recommended for the given materials: Turpentine, kerosene or soda water for hard and refractory steel; lard oil or soda water for soft steel and wrought iron; soda water for malleable iron; a flood of paraffine oil, if any for brass; kerosene or soda water for aluminum and soft alloys. Cast iron should be drilled dry or with a jet of compressed air.

* * *

The Bullard Machine Tool Co., Bridgeport, Conn., has issued a catalogue and treatise on the Bullard vertical turret lathe which is not only unusual typographically but a decided departure from the conventional catalogue. In fact, the idea in the preparation of this book was, first of all, to make it of practical value to shop superintendents and others interested in the efficient production of what is commonly known as faceplate work, and to subordinate the catalogue feature. For this reason, a large amount of space is given to illustrations showing many typical as well as unusual machining operations. It is pointed out that the cutting time only is productive in machine tool operation and that the design of the machine tool is only effective in so far as it reduces the waste time between cuts—hence, the significance of the title of this treatise, "Cutting Time Between Cuts." It contains 103 pages, 8½ by 11¼ inches, is printed on heavy paper and is beautifully illustrated. The fore part of the book contains large halftone illustrations, showing in detail the adaptability of the Bullard vertical turret lathe and its application to various classes of faceplate and chuck work. Beneath each illustration the operation is briefly described. Following, there are about twenty-four pages filled with diagrams showing the tool equipment and successive order of operations on a great variety of vertical turret lathe work. These diagrams are interesting as well as instructive, and show graphically the most modern practice in the boring and turning of many different machine parts. The latter half of the book relates to the turret lathe with its accessories and attachments. Various noteworthy features of the machine are described and illustrated, including such important parts as the table spindle, the bed, the cross-rail, the turrets, feeding mechanism, the lubricating system, the thread cutting attachment, the forming attachment, etc. The specifications for vertical turret lathes of various sizes and designs are also given. This book should be of value to every machine shop manager and superintendent, and every mechanical man, no matter what his position, should find a study of its pages instructive and interesting to an unusual degree.

DEVELOPMENT IN PLANER TYPE MILLING MACHINES

The modern superintendent or foreman who is responsible for the maintenance of the rate of production of a factory or shop is apt to take the most efficient forms of manufacturing equipment for granted. Such men make it their business to know the rates of production that are possible with different types of machine tools, and when a new job comes up they carefully consider the merits of the different machines on which it could be performed in order to select that type which they believe to be best suited for the requirements of the work. But the time of these men has been so fully occupied by their work that they have had little time to watch the development which has taken place in the machines that they use, unless such machines have been the product of the particular factory in which they are employed.

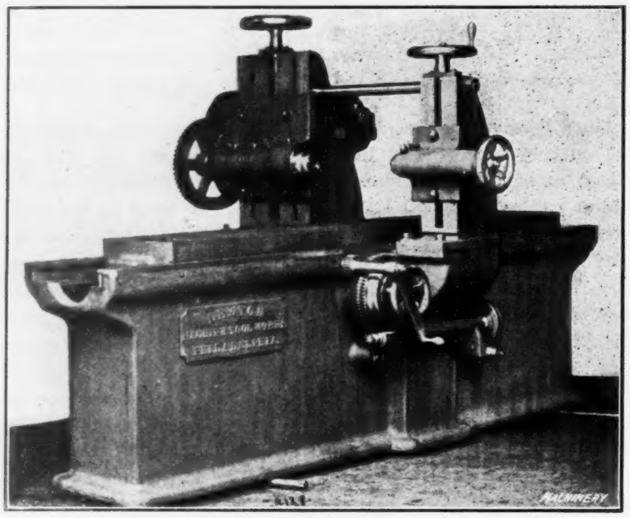


Fig. 1. First Heavy-duty Milling Machine built in the United States

Although of little practical value, it will doubtless be of interest to look back upon the progress which has been made in machine design—for instance, in the planer type of milling machine. The accompanying illustrations give an idea of the progress which has been made in this particular type of machine in the last thirty years. Fig. 1 shows what is said to be the first heavy-duty milling machine built in the United States. This particular machine is a product of the Newton Machine Tool Works, Inc., Philadelphia, Pa., and was built for the Stearns Mfg. Co., Erie, Pa., in 1884. Referring to the illustration it will be seen that the outer end of the cutter arbor was supported by a center, and the intermediate driving gears were supported by links. Later machines of this design were furnished with simultaneous vertical adjustment. Unfortunately, no records are available to show the rate of production obtained by this machine, which had a weight of about 10,000 pounds.

Previous to 1905 very few records were kept showing the output and cost of production of work on different types of machine tools, but in the opinion of the Newton Machine Tool Works a feed of about 1 inch per minute on slabbing operations is the best rate that was obtainable at this period with planer type milling machines. At about this time the Newton Machine Tool Works contracted for two machines for use in a large locomotive shop. These machines were built under a guarantee to take feeds of 2 inches per minute on slabbing operations; this was regarded as considerably in excess of average practice and was felt to be quite a risk. After the machines were shipped, the user reported that slabbing operations were being performed with feeds of from 6 to 8 inches per minute. Upon receipt of this advice an investigation was made and it was found that the increase in feed was made possible by the invention of the spiral inserted tooth high-speed milling cutter by Mr. C. D. Peck. This type of cutter is now known as the Taylor-Newbold cutter.

Fig. 2 shows a 50-inch size planer type milling machine which is one of the modern designs of the Newton Machine Tool Works. A comparison of this machine with the one antedating it by thirty years will show the wonderful progress which has been made. This machine is equipped throughout with steel or bronze gears. The table is of exceptionally heavy box-type construction, and the feed is obtained through an angular steel rack and spiral bronze pinion. The feed is obtained from a 50 horsepower motor shown at the left of the machine and the elevating of the rail is provided for by a special 3 horsepower motor mounted on the tie-beam. The spindle is driven by a steep lead bronze worm-wheel meshing with a hardened steel worm fitted with roller thrust bearings. The spindle has 12 inches cross adjustment by hand; it is 7⅜ inches in diameter and the minimum distance from the center of the spindle to the top of the table is 5 inches. The spindle speeds range from 15 to 31 revolutions per minute, power being obtained from a 50 horsepower General Electric 220 volt motor. The net weight of this machine is 70,000 pounds.

This machine is shown channeling to full depth and full width, in one operation, two large size rods at a table advance of 2¾ inches per minute. The maximum cut for channeling would probably be two channels 5 inches wide by 1¾ inch deep, milled to the full depth and full width with a table advance of 2½ to 2¾ inches per minute. Although the exact power required for this kind of work has not been determined, the thrust on the cutters is considerably greater than in slabbing operations on account of the resistance offered by the depth of the cut. For slabbing operations this machine would be capable of removing 1¼ cubic inch of metal per horsepower per minute. These rod milling operations are cited because they are among the most severe work that is encountered in milling practice. In order to stand up under such work, it is important to have all shafts and gears subject to opposed stresses with bearings in a common casting, in order to prevent the possibility of chatter or misalignment. Responsible builders are now producing machines capable of driving the best grade of cutters to the limit of their capacity. Efforts toward increased production will now be in the direction of securing continuous operation.

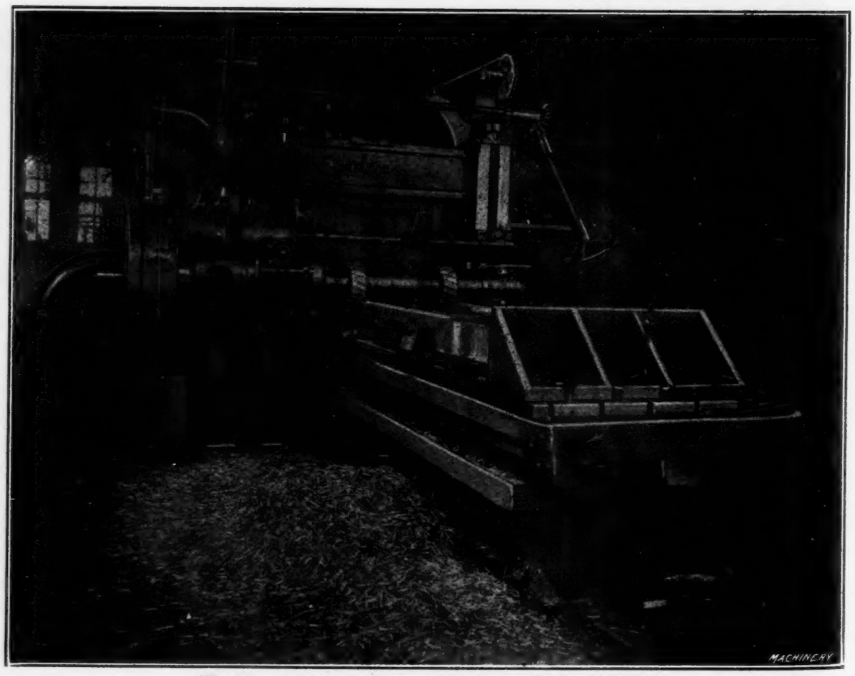


Fig. 2. A Modern Planer Type of Milling Machine

* * *

Electric iron ore smelting is making decided headway in Sweden, where during the past year some of the most prominent concerns in the iron industry have adopted the process.

SAVING OPERATIONS ON TURRET LATHES

BY CONRAD

In the September number of MACHINERY "Albion" contributed an article entitled, "Turret Lathe Set-up for a Small Screw," in which he explains how to save time in machining a conical headed screw. He points out the necessity of cutting down the number of operations to a minimum, owing to the heavy turret of the Herbert No. 2 turret lathe, so that

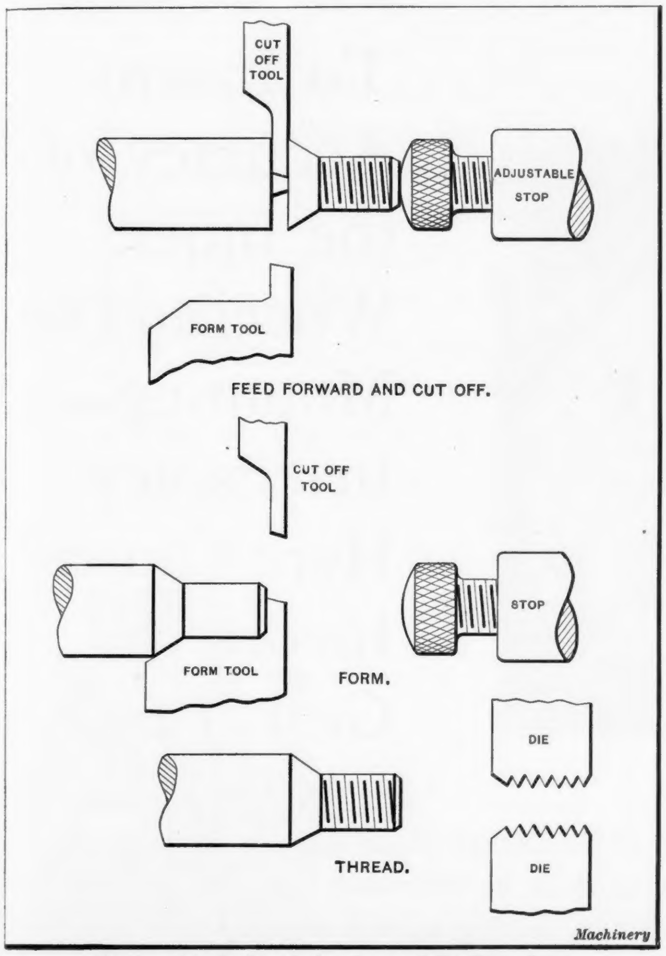


Fig. 1. Method of producing Screw of the Form shown

the fatigue caused by advancing, withdrawing and rotating the turret may be cut down as far as possible. The method advanced by "Albion" reduces the number of operations from six to three, the process being as follows: 1. Cut off and feed bar forward. 2. Turn and round end. 3. Thread.

If it is merely a question of simplicity and saving a few seconds on each piece, the writer suggests an even simpler method, which is illustrated in Fig. 1. This illustration shows the screw to be manufactured, with a slight difference in shape, the end being made flat and chamfered. The order of operations is: 1. Feed the bar forward to the stop held in a hole of the turret, with a screw finished by the preceding operation still to be cut off. 2. Cut off the finished screw with a tool in the back-rest of a tool-holder bolted onto the same face of the turret, and form the next screw with a tool in the front of the holder. These two operations are performed without rotating the turret. 3. Thread the work with a die-head held in the turret. In this way the whole job is finished with only two movements of the turret instead of three, as necessitated by "Albion's" method. Moreover, the die-head and the tool-holder may be located in two adjacent faces of the turret so that it is only necessary to move the turret through 1/6 of a revolution forward and back instead of having to revolve it all the way around. It will also be evident that as the outline of the forming tool is composed entirely of straight lines, it is quite simple to make.

It may not be out of place to state at this point that the question of the fatigue of the operator has evidently received due attention by the builders of the Herbert turret lathes, as all of their machines are now provided with a patent quick traverse motion for the saddle. With this arrangement it is only necessary to press down or lift up a small lever to start the mechanism, which automatically advances or withdraws the turret at a quick rate.

As a further example of how operations can be saved on automatic and semi-automatic machines, a brief description will be given of the method of procedure followed in producing pieces of the form illustrated in Fig. 2. This illustration shows a brass piece which was made on a full automatic machine. The machine was formerly arranged to make one of these pieces at a time, the order of operations being as follows: 1. Drill. 2. Form from front slide. 3. Countersink hole. 4. Tap. 5. Cut off from back slide. By speeding up, the best output that was obtainable by this method was three pieces per minute, but this was found to be insufficient.

In order to increase production, it was decided to make two pieces at a time, according to the method illustrated in Fig. 2. Working on this principle, the order of operations is as follows: 1. Drill through the depth of two pieces. 2. Form two pieces from front slide. 3. Countersink first piece. 4. Tap two pieces. 5. Cut off first piece from back slide. 6. Countersink second piece. 7. Cut off second piece from

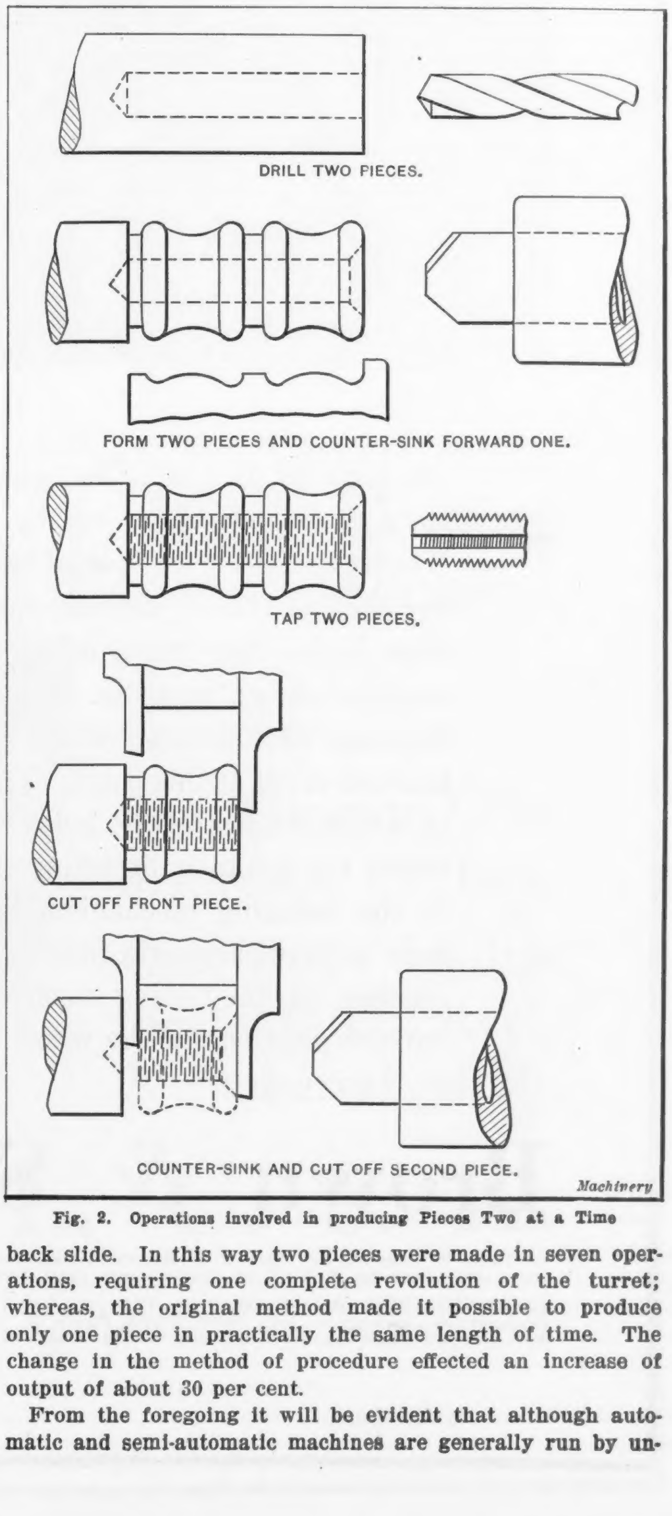
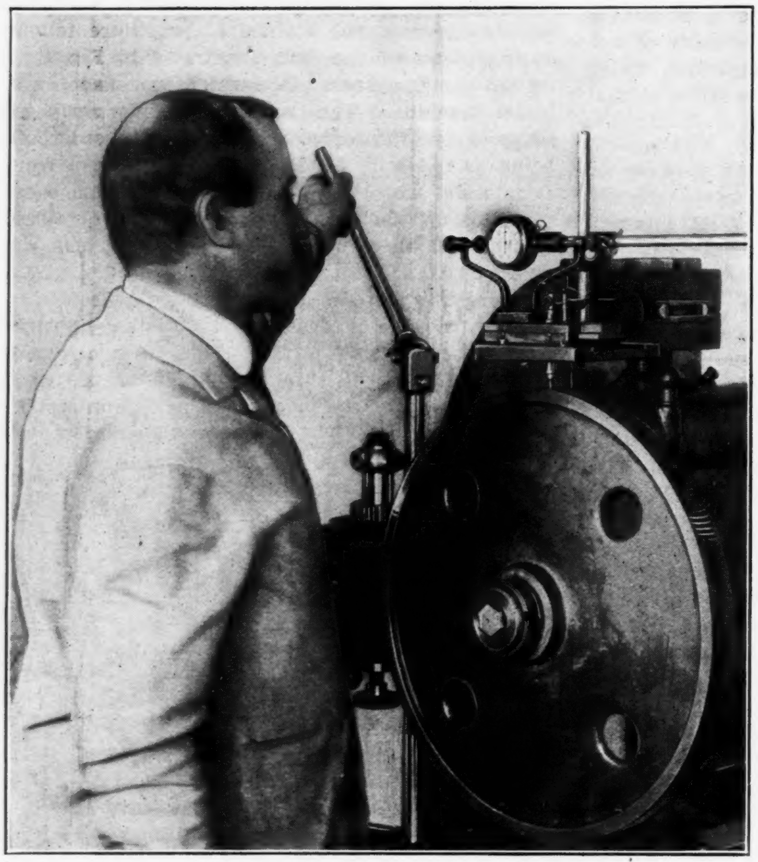


Fig. 2. Operations involved in producing Pieces Two at a Time

back slide. In this way two pieces were made in seven operations, requiring one complete revolution of the turret; whereas, the original method made it possible to produce only one piece in practically the same length of time. The change in the method of procedure effected an increase of output of about 30 per cent.

From the foregoing it will be evident that although automatic and semi-automatic machines are generally run by un-



A Final

To Insure Accuracy of the Index Wheel and its Mounting— Inaccuracy Here Causes Incorrect Gear Teeth.

Inaccuracies in the index wheel of Automatic Gear Cutting Machines show at once in gears cut by it as thick or thin teeth. B. & S. Index Wheels are cut with special machinery having master wheels which are as exact as skilled methods can produce. Each wheel is held to very close limits, ten hours being required to cut the index wheel of the machine shown opposite. Great care is also taken in finishing the bearings of the index wheel and spindle and in mounting the wheel to avoid error at this point. The cut above illustrates the careful manner in which we test every index wheel after it is mounted, with a special device for instantly detecting the slightest error in the teeth. Inaccuracy in the indexing mechanism is another cause of incorrectly cut gears, even with an accurate index wheel. To detect such errors, we apply another special testing mechanism capable of locating any error in the various positions of the wheel when rotated by its own power.

Brown & Sharpe Mfg. Co.,

OFFICES: 20 Vesey St., New York, N. Y.; 654 The Bourse, Philadelphia, Pa.; 626-630 Washington Blvd., Chicago, Ill.; 305 Chamber of Commerce Bldg., Rochester, N. Y.; Room 429, University Block, Syracuse, N. Y.

REPRESENTATIVES: Baird Machinery Co., Pittsburgh, Pa.; Erie, Pa.; Carey Machinery & Supply Co., Baltimore, Md.; E. A. Kinsey Co., Cincinnati, O., Indianapolis, Ind.; Pacific Tool & Supply Co., San Francisco, Cal.; Strong, Carlisle & Hammond Co., Cleveland, O., Detroit, Mich.; Colcord-Wright Machinery & Supply Co., St. Louis, Mo.; Perine Machinery Co., Seattle, Wash.; Portland Machinery Co., Portland, Ore.

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skilled labor, it is of great importance to have such machines in charge of a competent superintendent who is up to all sorts of "kinks" and methods of cutting down the time of production. The greatest savings in work of this kind are effected by reducing the idle operations as far as possible. It is not possible to go on increasing speeds and feeds *ad infinitum*, but it *is* possible to cut down the number of operations and the time which elapses between them, and this is the point that should receive attention when an endeavor is made to increase production.

* * *

LARGE OUTSIDE MICROMETERS

BY WILLIAM S. ROWELL*

Much has been done in recent years toward providing both inside and outside micrometers, but a more plentiful supply, especially in the large sizes, could be used to advantage in almost any shop. Doubtless first cost has much to do with keeping the stock down to its slender proportions. Consideration of the following may prove helpful to those who would help themselves.

The commercial inside micrometer up to about thirty-six inches is so good and cheap that it leaves little to be asked; above that size the writer has used a number of designs. Providing additional and longer rods to be used with the same head is usually a satisfactory solution. Solid rods may

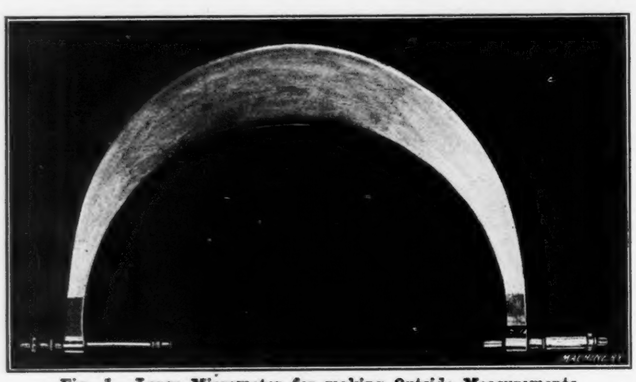

Fig. 1. Large Micrometer for making Outside Measurements

be used for almost any length but tubes are better adapted to the larger sizes.

There are a number of reasons for the scarcity of larger outside micrometers, but when the merits of sheet aluminum for the bow or frame become better known more of it will be used for this purpose. To use it, as is often done, by cutting as many and as large bows as can be laid out on a sheet of the metal without making use of its high ductility, is a waste of time and material. The proper way is to lay out the sizes wanted directly on the sheet metal and saw along the lines with a band saw. Kerosene is a good lubricant. The illustration Fig. 3 will give an idea of how a sheet of aluminum can be cut with a minimum of waste. The parts that come from the saw needing shaping can be easily forged into shape at a low heat. The smith should, if not familiar with the materials, experiment with a waste piece and note the proper forging heat. Sheet aluminum ⅜ inch thick is easily obtained and is generally conceded to be thick enough for all sizes up to thirty-six inches without any stiffening against side flexure. For larger sizes a thicker sheet, or perhaps better, an approximation of an I-beam section would provide the necessary stiffness.

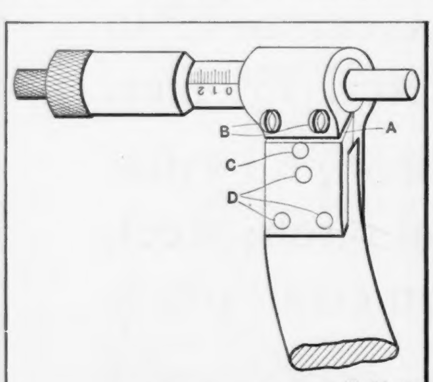

Fig. 2. Arrangement of the Clamp for holding the Micrometer Head

* Address: 1026 Dayton St., Hamilton, Ohio.

Tail-pieces should be drill rod steel 5/16 inch diameter if they are to extend six inches. The measuring points of both screw and tail-piece should be slightly rounded. This is more important than might at first appear. Such bows are not stiff enough to insure the flat ends remaining parallel. With both contact points slightly rounded a little lack of alignment makes no difference.

The illustration Fig. 1 shows an instrument of about thirteen inches capacity. The tail-rod shown is the short rod from an eight- to thirty-two-inch inside micrometer. The micrometer screw is held in place by two clamping screws *B* shown in Fig. 2. The steel clip that holds the micrometer

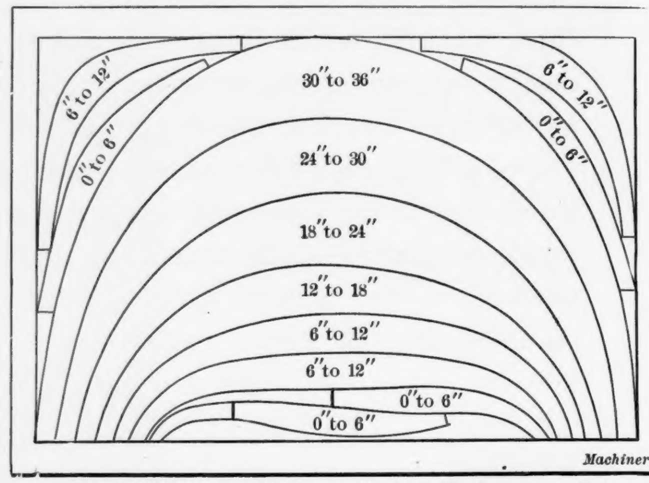

Fig. 3. Method of cutting up a Sheet of Aluminum for a Set of Micrometer Frames

screw was not originally intended for a removable screw and was held to the aluminum bow by the three rivets *D*. When the saw cut *A* was made, a rivet was added at *C* to stiffen the clip. In this way one micrometer screw may serve two or more large size bows. Bows as small as eighteen inches and under should usually each have its own screw, as small size instruments are generally in use.

Of course it is understood that such instruments are never standards. They are transfer instruments as strictly as were the two-leg calipers of our fathers, but when provided with a micrometer screw of one-inch run eighteen standard gages will suffice to set such calipers for all sizes from zero to thirty-seven inches.

* * *

ADVERTISING WITH MOVING PICTURES

The possibilities of the moving picture as an advertising agent is fully realized in Europe as well as in America. A firm in London has prepared an exhibition of moving pictures illustrating British manufactures and industries, and films dealing with this subject are to be shown in the leading cities of the European continent, North and South America and the British colonies. The first tour will be one of northern Europe, during which exhibition the films will be shown in some sixty cities. These exhibitions will be held during the daytime and will be free, invitations being issued to the leading business men in each city, the cost being defrayed by the manufacturers whose products or methods are shown. In connection with this tour, a commercial reference book in English, German and French will be published and about sixty thousand copies will be distributed to the visitors to the exhibitions. It is expected that this method will do much to bring the names of British manufacturers before foreign buyers.

* * *

The following mixture is, according to *Foundry*, suitable for cores for aluminum and brass castings: Silica or lake sand, 28 parts; molding sand, 12 parts; and linseed oil compound, or plain linseed oil, 1 part, by weight. The lake and molding sands are first thoroughly mixed, water being added until almost damp enough for use, when the linseed oil is thoroughly mixed into the sand. It is very important that there is a complete mixture of the oil and sand. The cores should be baked in a hot oven.

LONGEST RAILWAY BRIDGE IN WORLD

The longest railway bridge in the world will be constructed shortly for the improved line between Berlin, Germany, and Stockholm, Sweden. At present, the railway trains are carried by large ferries a distance of about seventy miles from a point in southern Sweden to the island of Rügen, in Germany. The trains then pass across the island of Rügen, but must again be ferried from this island to the German mainland, a distance of about two miles. The bridge will connect the island of Rügen with the German mainland and make the second ferry trip unnecessary. The length of the bridge will be 10,725 feet, divided into twenty-two spans. The height of the bridge from the water level will be 105 feet.

* * *

PERSONALS

J. L. Peden, general manager of the Universal Screw Cutting Co. of America, Philadelphia, Pa., has resigned his position.

D. Walker Wear, formerly purchasing agent of the Chicago Tunnel Co., has been elected vice-president and director of the Stow Mfg. Co., Binghamton, N. Y.

Henry M. Leland, general manager of the Cadillac Motor Car Co., Detroit, Mich., was elected president of the Society of Automobile Engineers at the January meeting in New York City.

H. H. Robertson, president of the Asbestos Protected Metal Co., Beaver Falls, Pa., has been elected vice-president of the Pittsburg branch of the National Council for Industrial Safety.

L. G. Daniels has been made general manager of the Rockford Drilling Machine Co., Rockford, Ill., succeeding S. H. Reck, who sold out and withdrew from the company a few months ago.

C. R. McCullough, who has been connected with the Detroit office of Manning, Maxwell & Moore, Inc., for the past two years, has entered the employ of the Lees-Bradner Co., Cleveland, Ohio.

John Becker, Jr., was elected treasurer and general manager of the Becker Milling Machine Co., Hyde Park, Mass., following the resignation of his father, John Becker, who has retired from business.

E. A. Muller of the King Machine Tool Co., Cincinnati, Ohio, has been appointed receiver for the Modern Machine Tool Co. of Cincinnati. The company is said to be solvent, having $50,000 assets and $20,000 liabilities.

S. Wolff, former manager of the Cleveland office of the Allis-Chalmers Mfg. Co., Milwaukee, Wis., has been appointed Chicago manager for the DeLaval Steam Turbine Co., Trenton, N. J., manufacturer of steam turbines, centrifugal pumps, etc., with offices in the People's Gas Bldg.

E. M. Chadwick, formerly of the Fairbanks Co., has been appointed manager of the Buffalo branch of Manning, Maxwell & Moore, Inc., and D. A. Hamilton, formerly of the Reed-Prentice Co., Worcester, Mass., has been appointed assistant at the Detroit branch of Manning, Maxwell & Moore, Inc.

W. H. Shafer, formerly with the Cincinnati-Bickford Tool Co., Cincinnati, Ohio, and recently with the Rochester Boring Machine Co. of Rochester, N. Y., has again become associated with the Cincinnati-Bickford Tool Co. as special representative in connection with the company's selling organization.

Albert A. Dowd, formerly in charge of the estimating department of the Bullard Machine Tool Co., Bridgeport, Conn., is now in business for himself as a production engineer. He is prepared to furnish details of horizontal and vertical lathe tool equipments as a specialty. His address is 84 Washington Terrace, Bridgeport, Conn.

C. U. Scott, Davenport, Iowa, has resigned his position at the Rock Island Arsenal, where he has been for the past ten years in charge of the hardening and heat-treating department, in order to devote all his time to his own business of tool hardening, heat-treating, casehardening, galvanizing, tinning, brazing, bluing and manufacture of furnaces.

A. D. Pentz is the inventor of the toolroom boring machine built by the Newton Machine Tool Works, Philadelphia, Pa., and illustrated and described in the November, 1913, number of MACHINERY. Mr. Pentz, who is with the General Electric Co., West Lynn, Mass., received the John Scott medal from the Franklin Institute in 1891, for machines in which the same principles that make this machine distinctive and unique were embodied.

Prof. David N. Camp, president of the Skinner Chuck Co., New Britain, Conn., was the guest of honor at an annual banquet tendered by the company to its employes at the New Britain Club, December 23. There were about one hundred and twenty men present and Prof. Camp was the principal speaker and honored guest of the evening. He will soon be ninety-four years old, a fact that made his presence at the banquet the more notable.

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OBITUARIES

Herman C. Meinholtz, vice-president of the Heine Safety Boiler Co., St. Louis, Mo., died in St. Louis December 24, aged forty-five years. Mr. Meinholtz entered the employ of the Heine Safety Boiler Co. at the age of nineteen as a draftsman and was continuously connected with that company up to the time of his death. He was made superintendent in 1895 and vice-president in 1907. He had entire charge of the company's shop when it was established in 1899, and under his general direction the new factory was designed and built in 1909. He is survived by his widow and five children.

COMING EVENTS

April 4-11.—First National Efficiency Exposition and Conference, Grand Central Palace, New York City. Walter H. Tallis, director, Efficiency Society, Inc., 41 Park Row, New York City.

May 1-October 31—Anglo-American Exposition, London, England, to celebrate the centenary of peace between the United States and Great Britain. American executive offices: Woolworth Bldg., New York City. Charles J. Kiralfy and Albert E. Kiralfy, commissioners general.

June 15-17.—Annual convention of the American Supply & Machinery Manufacturers' Association at White Sulphur Springs, West Virginia; New Green Brier Hotel, headquarters. General offices of the association, Woolworth Bldg., New York City.

September 20-25 (1915).—International Engineering Congress, San Francisco, Cal., in connection with the Panama-Pacific International Exposition. W. F. Durand, chairman, Foxcroft Bldg., San Francisco, Cal.

NEW BOOKS AND PAMPHLETS

Annual Report of the Secretary of Commerce—1913. 150 pages, 6 by 9 inches. Published by the Department of Commerce, Washington, D. C.

Educational Directory, 1913. 159 pages, 6 by 9 inches. Published by the United States Bureau of Education, Washington, D. C., as Bulletin 557.

Kansas Fuels: Coal, Oil, Gas. By P. F. Walker and Walter Bohnstengel. 40 pages, 6 by 9 inches. Published by the University of Kansas, Lawrence, Kans., as Engineering Bulletin No. 3.

Tests of Permissible Explosives. By Clarence Hall and Spencer P. Howell. 313 pages, 6 by 9 inches. Published by the Bureau of Mines, Department of the Interior, Washington, D. C., as Bulletin 66.

Metal-Mine Accidents in the United States, 1912. Compiled by Albert H. Fay. 76 pages, 6 by 9 inches. Published by the Bureau of Mines, Department of the Interior, Washington, D. C., as Technical Paper 61.

Special Studies in Electrolysis Mitigation. By E. B. Rosa and Burton McCollum. 55 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Technologic Paper of the Bureau of Standards 27.

The Use and Misuse of Explosives in Coal Mining. By J. J. Rutledge and Joseph A. Holmes. 54 pages, 6 by 9 inches. Published by the Bureau of Mines, Department of the Interior, Washington, D. C., as Miners' Circular 7.

Windage Resistance of Steam-turbine Wheels. By Edgar Buckingham. 44 pages, 7 by 10 inches. Published by the Bureau of Standards, Washington, D. C., as Reprint 208 of the Bulletin of the Bureau of Standards, Vol. 10.

Electrolysis in Concrete. By E. B. Rosa, Burton McCollum, and O. S. Peters. 136 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Technologic Paper No. 18 of the Bureau of Standards.

Metallurgical Coke. By A. W. Belden. 48 pages, 6 by 9 inches. Illustrated. Map showing location of coke oven plants in the United States. Published by Bureau of Mines, Department of the Interior, Washington, D. C., as Technical Paper 50.

Melting Points of Some Refractory Oxides. By C. W. Kanolt. 19 pages, 7 by 10 inches. Published by the Bureau of Standards, Department of Commerce, Washington, D. C., as Reprint 212 from the Bulletin of the Bureau of Standards, Vol. 10.

Analysis of Alternating-Current Waves by the Method of Fourier. By Frederick W. Grover. 77 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Reprint 203 from the Bulletin of the Bureau of Standards, Vol. 9.

A Comparative Study of American Direct Current Watthour Meters. By T. T. Fitch and C. J. Huber. 30 pages, 7 by 10 inches. Published by the Bureau of Standards, Department of Commerce, Washington, D. C., as Reprint 207 of the Bulletin of the Bureau of Standards, Vol. 10.

Foreign Publications for Advertising American Goods. 236 pages, 6 by 9 inches. Published by Bureau of Foreign and Domestic Commerce, Department of Commerce, as No. 10 of the Miscellaneous Series.

This publication will be useful to American manufacturers who wish to advertise their wares in foreign journals. It gives the foreign publications, advertising rates, circulation, subscription prices, etc., for Canada, Mexico, West India, South America, Europe, Asia, Oceania, Africa, etc.

Bureau of Supplies of the Department of Water Supply, Gas and Electricity, New York City Report. To Henry S. Thompson, commissioner. By Elihu C. Church, secretary. 6½ by 10 inches. 93 pages. Illustrated. Published by the City of New York.

This report is of much interest to municipal officers in general. It outlines the plan and scope, the organization and administration of the Bureau. Details of purchasing and inspection are given, and storage and issue of supplies, methods of keeping records and accounts are described.

Mechanical World Electrical Pocket Book for 1914. 311 pages, 4 by 6 inches. Illustrated. Published by Emmott & Co., Ltd., Manchester, England. Distributed in the United States by Norman & Remington, Baltimore, Md. Price 25 cents.

This book is similar in plan and scope to the well known Mechanical World Diary and Year Book in the mechanical field. It treats of the electrical units, magnetic laws, characteristics of dynamos and motors, direct and alternating current systems, transformers, accumulators, wiring, electrical measuring instruments, electric lamps, electric lighting, electromagnets, electricity in coal mines. Tables of logarithms and other useful tables are included, and a diary for every day in the year.

Bulletins of the Engineering Experiment Station, University of Illinois. Vol. 9. Comprising Bulletins 63 to 67. 6 by 9 inches. Published by the Engineering Experiment Station, University of Illinois, Urbana, Ill.

This volume comprises bulletins which have been previously noticed in MACHINERY as follows: "Entropy-Temperature and Transmission Diagrams for Air," by C. R. Richards; "Tests of Reinforced Concrete Buildings Under Load," by Arthur N. Talbot and Willis A. Slater, "The Steam Consumption of Locomotive Engines from the Indicator Diagrams," by J. Paul Clayton; "The Properties of Saturated and Superheated Ammonia Vapor," by G. A. Goodenough and William Earl Mosher; "Reinforced Concrete Wall Footings and Column Footings," by Arthur N. Talbot.

Mechanical World Pocket Diary and Year Book for 1914. 443 pages, 4 by 6 inches. Illustrated. Published by Emmott & Co., Ltd., Manchester, England. Distributed in the United States by Norman & Remington, Baltimore, Md. Price 25 cents.

This well known compilation of useful engineering notes, rules, tables and data has been issued consecutively for twenty-seven years. The low price of the publication, the large amount of valuable data contained, and the small size have made it justly popular. It treats of steam and steam engines, steam turbines, condensers, boilers, etc., gas engines, gas producers, steam generators and materials of construction, shafting, gearing, machine shop practice, belting, micrometers, hydraulics, gages, weights and measures, logarithms, trigonometrical tables, etc. A diary for every day in the year is included and a complete index makes easy reference to the matters contained.

Investigating an Industry. By William Kent. 126 pages, 5 by 7½ inches. Published by John Wiley & Sons, Inc., New York City. Price $1.

In the introduction, written by H. L. Gantt, the purpose of the book is outlined as based on the old saying, "Look before you leap," or in other words, "Find out all possible facts about an industry before drawing conclusions." The contents by chapters are: General Considerations, A Business Diagnostician, The Diagnosis—The Factory, The Accounting and Sales Department, The Doctor's Preliminary Report, The Salesmen's Conference, The Doctor's Opinions and Recommendations, Proposed Reorganization of the Board of Directors, Duties of the Functional Committees of the Board of Directors, A New Kind of Factory Expert—The Leak Hunter, Locating an Industry. The author likens a run-down business to a sick man and the efficiency expert to the doctor. It is the doctor's function to diagnose the ailment of the patient and to prescribe the remedies.

Bulletins of the Engineering Experiment Station, University of Illinois. Vol. 8. Comprising Bulletins 58 to 62. 6 by 9 inches. Published by the Engineering Experiment Station, University of Illinois, Urbana, Ill.

These bulletins, which have been previously reviewed in MACHINERY, are as follows: "A New Analysis of the Cylinder Performance of Reciprocating Engines," by J. Paul Clayton; "The Effects of Cold Weather Upon Train Resistance and Tonnage Rating," by Edward C. Schmidt and F. W. Marquis; "The Coking of Coal at Low Temperatures with a Preliminary Study of the By-products," by S. W. Parr and H. L. Olin; "An Extension of the Dewey Decimal System of Classification Applied to the Engineering Industries," by L. P. Breckenridge and G. A. Goodenough; "Characteristics and Limitations of the Series Transformer," by A. R. Anderson and H. R. Woodrow; "The Electron Theory of Magnetism," by Elmer H. Williams.

Work, Wages and Profits. By H. L. Gantt. 312 pages, 5 by 7½ inches. Published by the Engineering Magazine Co., New York City. Price $2.

The second edition of this work which appeared in 1910 has been thoroughly revised and much enlarged, the first edition containing only 194 pages. The work contains twenty-seven illustrations, including charts in two colors. The new material includes an extended treatment of the task idea and a new chapter on the results of scientific management. The contents by chapter heads are: The Application of the Scientific Method to the Labor Problem, The Utilization of Labor, The Compensation of Workmen, Day Work, Piece Work, Task Work With a Bonus, The Task Idea, Training Workmen in Habits of Industry and Cooperation, Fixing Habits of Industry, Results, Prices and Profits, A Practical Example. A pleasing feature of Mr. Gantt's work as an efficiency expert is his sympathy with all concerned. He regards greater efficiency from the standpoint of the true economist and not from the merely selfish viewpoint of an employer who would increase his profits without consideration of the effect on the workman or on humanity as a whole.

Practical Patternmaking. By F. W. Barrows. 347 pages, 5¼ by 7¼ inches. 159 illustrations. Published by Norman W. Henley & Son, New York City. Price $2.

The first edition of Barrows' work on patternmaking was published in 1906. New material has been added and incomplete sections filled out. The number of specific examples has been increased. The contents comprise: Patternmakers and Patternmaking, How Some Folks Make Patterns, Some Methods, Patternmakers, Lumber, Varnish, Miscellaneous Materials, The Bench and Its Attachments, Hand Tools, Bench Work, Machine Tools for Patternmakers, The Band-saw, The Circular Saw, The Lathe, Fillets, Stavework, Cant or Segment Work, Patterns for Belt Pulleys, Patterns for Cable Pulleys, Making Patterns for Chain Wheels, Patterns for Steam Cylinders, One Way of Making a Crosshead, Making Gear Patterns, Propeller Wheels, Patterns for Screws, Traction Wheels for Farm Engines, Globe-valve Patterns, An Example in Projection, Common Practice, Some Patterns, A Stripping-plate Job, A Vibrator-plate Pattern, The Evolution of the Globe Valve Core-box, Multiple Core-boxes, Cost of Patterns, The Marking and Record of Patterns, Pattern Accounts.

Heating and Ventilation. 335 pages, 6 by 9 inches. Published by the B. F. Sturtevant Co., Hyde Park, Boston, Mass.

This book forms part of the advertising literature of the company and bears the catalogue number 215. It is, however, a textbook and work of reference on heating and ventilating for engineers and all others concerned with any phase of the problems of heating and ventilating buildings. The first edition of the work was published over twenty-five years ago and new editions have been frequently published since. The advancement of the science of heating and ventilating has been rapid, and in the present edition the work has been revised in such a manner as to make it equally useful to both engineer and layman. The work is divided into two parts, the first part containing the text matter and the second a collection of tables for the use of engineers, etc. The contents by chapter heads are as follows: Theoretical Considerations; Ventilation; Heat, Heating and Cooling; The Sturtevant System; Heating and Ventilating Apparatus; Heating and Ventilating Calculations; Testing; Special Problems of Application; Typical Installations; Sturtevant Apparatus; Tables. While the book is intended for wide circulation, its cost makes general free distribution prohibitive.

Compressed Air Practice. By Frank Richards. 326 pages, 6 by 9 inches. 94 illustrations. Published by the McGraw-Hill Book Co., Inc., New York City. Price $3 net.

The author published a small book called "Compressed Air" about twenty years ago, and this work forms part of the present volume. The advance in compressed air practice and the many developments of its use during the twenty years elapsed are great and varied. The contents comprise: Atmospheric Generalities, Definitions and General Information, The Compressed Air Problem, Tables and Diagrams for Computations in Air Compression, The Indicator on the Air-compressor, Single-stage Compression, Two-stage Air Compression, Two-stage and Three-stage Compression, Air-compressor Regulating Devices, The Drive of the Compressor, The Turbo Compressor, The Taylor Compressor—The Humphrey Pump, Power Cost of Compressed Air, Power from Compressed Air, The Air Receiver, Pipe Transmission, Re-heating Compressed Air, Compressor and Receiver Fires and Explosions, Side Lines for the Air-compressor, Gasoline by Compression—Liquified Natural Gas, Rock Drill Developments, The Electric Air Drill, Compressed Air for Raising Water, The Air Lift, Air for Large Steam Hammers, Diving Bell and Caisson, Air Jet—Sand Blast—Cement Gun, Liquid Air—Oxygen from the Atmosphere. The work will be welcomed by all who appreciate clear common sense treatment of an engineering subject.

Machinery's Handbook. Compiled by Erik Oberg and Franklin D. Jones. 1400 pages, 4½ by 7 inches. Published by the Industrial Press, New York City. Price $5.

In 1898 MACHINERY began the publication of data sheets in supplement form. These sheets comprised a great variety of tables, diagrams and data for the machinist, toolmaker, draftsman, designer, mechanical engineer and others in the mechanical engineering field. As time passed the data sheets grew in volume until they formed a mass of material difficult to index and handle. Recognizing the need of putting this valuable material in convenient form for general use, MACHINERY'S editors have compiled a Handbook using the best of the material published in MACHINERY and the data sheets during the past twenty years. Much additional matter has been included in order to round out a complete work of reference, for the user, and it is believed to be the most condensed and best arranged work of the kind ever published for the mechanical man in any position, whether it be that of a machinist, toolmaker, draftsman, designer, foreman, superintendent or general manager. Special pains have been taken to present the mathematical tables and formulas in attractive and convenient form. In many cases the formulas are accompanied with examples worked out, and with such illustrations the practical man is able to use formulas that he would shrink from otherwise. The sections on heat-treatment of steel, strength of materials, motor power of machine tools, broaching and screw threads are exhaustive. Within the covers of the book are included a complete treatise on spur, bevel, helical and worm gears, and the section on springs is believed to be the best treatment of the subject extant. Space does not permit of reviewing the contents in full, and the heads of sections only are quoted to give a general idea. They are as follows: Mathematical Tables; Principal Methods and Formulas in Arithmetic and Algebra; Logarithms and Logarithmic Tables; Areas and Volumes; Solution of Triangles and Trigonometrical Tables; Geometrical Propositions and Problems; Principal Methods and Formulas in Theoretical Mechanics; Strength of Materials; Riveting and Riveted Joints; Strength and Properties of Steel Wire; Strength and Properties of Wire Rope; Formulas and Tables for Spring Design; Torsional Strength—Shafting; Friction; Plain, Roller and Ball Bearings; Keys and Keyways; Clutches and Couplings; Friction Brakes; Cam Design and Cam Milling; Spur Gearing; Bevel Gearing, Worm Gearing, Spiral and Herringbone Gearing; Epicyclic Gearing; Belts and Pulleys—Machine Tool Drives; Rope Transmission; Transmission Chain and Chain Drives; Crane Chain and Hooks; Bolts, Nuts, Screws, Wrenches, Handles, Handwheels and Other Machine Details; Speeds and Feeds for Machine Tools—Tool Grinding; Automatic Screw Machine Practice; Tapping and Threading; Lubricants for Machining Operations; Running, Shrinkage and Forced Fit Allowances; Measuring Instruments and Gaging Methods; Change Gears for Spiral Milling—Leads and Corresponding Angles; Milling Machine Indexing; Jigs and Fixtures; Grinding and Grinding Wheels—Polishing and Lapping; Punches, Dies and Press Work—Drop-forging Dies; Broaches and Broaching Operations; Classification, Testing and Application of Files; Screw Thread Systems and Thread Gages; Taps and Threading Dies; Milling Cutters; Reamers; Twist Drills, Counterbores and Boring Bars; Heat-treatment of Steel—Hardening, Tempering and Annealing; Testing the Hardness of Metals; Principles of Iron and Steel Manufacture; Foundry and Pattern Shop Practice; Extrusion of Metals; Die Casting; Forge Shop Equipment; Forge Shop Welding Methods; Autogenous Welding; Welding with Thermit; Electric Welding; Soldering and Brazing; Etching and Etching Fluids; Coloring Metals; Horsepower Required for Machine Tools and Forging Machinery —Electric Motor Drive; Care of Electrical Machinery—Dynamo and Motor Troubles; Properties and Weights of Materials; Composition of Alloys; Information Relating to Heat—Comparison of Thermometer Scales; Pneumatics—Air Compression—Flow of Air; Water Pressures and Flow of Water; Pipe and Pipe Fittings; Lutes and Cements; Weights and Measures; Metric System of Measurements and Conversion Tables; Manufacturing Plant Appraisal; Drawing, Tracing and Blueprint Papers; Principal Patent Law Regulations.

NEW CATALOGUES AND CIRCULARS

Cincinnati Iron & Steel Co., Cincinnati, Ohio. Circular of the "Cisco" eighteen-inch engine lathe.

General Electric Co., Schenectady, N. Y. Bulletin No. A 4199 illustrating and describing railway motor gears and pinions.

Deane Steam Pump Co., 115 Broadway, New York City. Bulletin D 224 on horizontal double-acting single-cylinder power pumps.

Brown Instrument Co., Philadelphia, Pa. Calendar for 1914 illustrated with a view of a twelve-inch gun in action at Fort Wadsworth, New York City.

General Electric Co., Schenectady, N. Y. Bulletins A 4143 and A 4148 on belt-driven alternators Form B and small plant direct-current three-wire switchboards of 125 and 250 volts and 10 to 100 K. W. capacity, respectively.

Noble & Westbrook Mfg. Co., Hartford, Conn. Catalogue of Dwight Slate marking machines, die-holders and dies. The company is prepared to make steel marking dies for all purposes.

Morse Chain Co., Ithaca, N. Y. Circular of Morse chain drives, showing applications to motor-driven machine tools, engine drives, textile machinery, rubber mills, calender rolls, etc.

Stow Mfg. Co., Binghamton, N. Y. Circular of portable tools comprising emery grinders, light drilling machines, toolpost grinders, electric hand buffers, electric breast drills, etc.

Challenge Machine Co., Inc., Philadelphia, Pa. Catalogue of "Challenge" floor grinders, illustrating a variety of grinders, details of construction, wheel guards, belt polishing attachment, etc.

Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. Bulletin No. 1002 on Shepard electric cranes and hoists, illustrating their use in steel car plants and on the docks of New York Harbor.

Allen-Bradley Co., 495-497 Clinton St., Milwaukee, Wis. Circular describing "Type H" alternating-current motor starters. Special emphasis is laid on the motor protective features of the rheostats on these starters.

Wheelock, Lovejoy & Co., 23 Cliff St., New York City. Circular of the Keen impact ball tester for testing the softness of steels and other metals. The tester was illustrated and described in the July, 1913, number of MACHINERY.

Watson-Stillman Co., 192 Fulton St., New York City. Catalogue 89 on heating, chilling and die presses of the hydraulic type. Die sinking presses, both power and hand operated are illustrated. The hand die sinking presses include the four-column and open-jaw types.

Hammacher, Schlemmer & Co., 4th Ave. and 13th St., New York City. Circular of the "Yankee" bench drill, hand-operated, and "Yankee" vise for same. The "Yankee" bench drill weighs fifty-seven pounds and is intended for small shops, farm use, etc. The vise may be used on the drill or on a bench.

Chicago & Northwestern Railway Co., Chicago, Ill. Safety Bulletin No. 4. These bulletins show the dangers of railroading and how accidents happen, and illustrate the rules provided for avoiding accidents. A slogan of the company is, "Remember that it is better to cause a delay than to cause an accident."

National Malleable Castings Co., Sharon, Pa. Circular of electric steel castings, illustrating a Heroult furnace installed at the company's Sharon works and typical castings made from it. The advantages of steel castings made from the electrical furnace are enumerated and records of fatigue tests are given.

Doehler Die-Casting Co., Court and Ninth Sts., Brooklyn, N. Y. Circular of Doehler babbitt-lined bronze bearings for internal combustion motors. These bearings were used by the Moline Automobile Co. on the engine recently tested at the Automobile Club of America laboratory, running two weeks without a stop.

Edward Wilbur, 125 Summer St., Boston, Mass. Card advertising and illustrating the Greenerd belt pole for facilitating the shifting of belts while standing on the floor. The pole is 9 feet long, made of hard wood and steel, and is provided with a

socket or floor stand that insures keeping it always in a generally known place.

General Electric Co., Schenectady, N. Y. Catalogue of electric fans for table, wall and ceiling mountings, also describing small ventilating outfits. Among the table fans mentioned are fans which are moisture-proof and have non-corrosive fittings. These are designed especially for use on shipboard.

Taft-Peirce Mfg. Co., Woonsocket, R. I. Program of second annual Joy Fest held in Harris Hall, January 16. The company has found this annual event to be very popular and a help towards promoting harmony and cooperation throughout the entire organization. The attendance at the entertainment and dance numbered between 600 and 700.

Huther Bros. Saw Mfg. Co., Inc., 1108 University Ave., Rochester, N. Y. Circular of the Huther Bros. milling saws made of two crucible steel spring tempered blades riveted together and provided with inserts of high-speed steel. The saws are made in all sizes from 12 to 24 inches diameter or larger, ranging in thickness from 3/16 to 3/8 inch.

Henry & Wright Mfg. Co., 760 Windsor St., Hartford, Conn. Pocket edition of catalogue on ball bearing sensitive type drilling machines. Single spindle and multiple spindle machines are illustrated and details of the power transmission system. The catalogue also shows a small sensitive radial drilling machine in both bench and floor patterns.

Pawling & Harnischfeger Co., Milwaukee, Wis. Bulletin 401 on the Type "H" crane, in which special provision has been made for safeguarding gears and other dangerous parts. Other salient features are accessibility of parts, no overhanging gears or pinions, gears of cast steel, pinions of forged steel, all gears submerged in grease and enclosed in oil-tight cases, motor and bridge brakes of heavy clam-shell type, etc.

Graton & Knight Mfg. Co., Worcester, Mass. Belting manual intended for buyers, users and caretakers of belts. The periodical inspection of belts is advised, and directions are given for remedying common belt troubles. Instructions are included for repairing laps and making double belts endless on the pulleys, lacing belts, sizes of punched holes and laces recommended in belts of various widths, mechanical rules regarding belting, tables of circumferential speeds per minute, and other valuable information on the transmission of power. The manual should be studied by users of belting generally.

Gurney Ball Bearing Co., Jamestown, N. Y. Specification sheet of Gurney ball bearings, giving the number, bore, outside diameter, width, number of balls, rated load, revolutions per minute and price of annular ball bearings for shaft diameters 0.59 to 4.33 inches diameter. The sheet gives the equivalent millimeter dimensions of bore, outside diameter and width. A valuable feature is a table of constants for finding the rating of bearings when run at speeds other than those specified. This specification sheet should be appreciated by machine designers and users of ball bearings generally, as its use should prevent making serious mistakes in specifying the use of ball bearings in machine construction.

TRADE NOTES

Ideal Tool & Mfg. Co., Beaver Falls, Pa., has increased its capital stock from $5000 to $75,000.

National-Acme Mfg. Co., Cleveland, Ohio, shipped from its factory in Cleveland in January seventy-five automatic screw machines, making nine carloads, to Paris for distribution in Europe.

Vulcan Engineering Sales Co., Chicago, Ill., has moved to its factory at 2059 Elston Ave. The change also includes the sales offices of the Mumford Molding Co., Hanna Engineering Works and the Q. M. S. Co.

Becker Milling Machine Co., Hyde Park, Mass., reports that the business in the Becker horizontal and vertical milling machine is very good. The company is so far behind with its orders that it has difficulty in making deliveries when promised.

L. S. Starrett Co., Athol, Mass., announced to its employes December 24 that those who had worked for the company a full year would be paid a sum equal to two per cent of the total wages paid during the year 1913, or about one week's extra pay.

Medart Patent Pulley Co., St. Louis, Mo., which has been organized since 1879 and operated under a co-partnership agreement by Philip and William Medart, is now incorporated with a capital stock fully paid of $350,000, and a voluntary surplus of $52,000. The officers are William R. Medart, president and treasurer; William F. Mulhall, secretary.

C. & C. Electric & Mfg. Co., Garwood, N. J., has discontinued its Pittsburg office in charge of Ludwig Hommel & Co. This territory is to be taken care of hereafter by the company's Philadelphia manager, J. C. Chamberlin. The company has appointed F. A. Saylor, with offices in the Greenwood Bldg., Sixth and Vine Sts., Cincinnati, Ohio, agent for the southern part of Ohio.

American Pulley Co., Philadelphia, Pa., has increased its manufacturing capacity twenty-four per cent. A new warehouse has been built that will easily store 40,000 belt pulleys. The structure is fireproof, having brick walls, tile roof, concrete floors, metal racks, metal bins and shelving and even metal window frames. The second floor of the building is used as business offices and the former office space has been added to the machine shop.

Cassady-Fairbank Mfg. Co., 6102-6130 La Salle St., Chicago, Ill., manufacturer of hardware specialties, steel stampings and automatic machine work, has bought out the East Side Foundry Co. of South Chicago and has moved the business to its main plant at 6102-6130 La Salle St. The company will continue the regular line as formerly manufactured by the East Side Foundry Co., and will also manufacture non-corrosive white metal which will be made a specialty. This metal will be known as the "Comet non-corrosive white metal."

Graton & Knight Mfg. Co., Worcester, Mass., has purchased and equipped a branch factory in Detroit, Mich. The plant and business of the Wayne Belting Co., 112 Second Ave., was purchased and the equipment moved to 266 Jefferson Ave. E. The Graton & Knight Mfg. Co. will manufacture the same standard line of leather belting and automobile specialties as has been produced in the Worcester plant. Besides manufacturing belting and leather specialties, the company will do all kinds of leather repair work at the Detroit plant. The new factory is in charge of C. F. Urquhart.

David Brown & Sons (Hfd.), Ltd., Park Works, Lockwood, Huddersfield, England, has acquired the business and patents of John Sunderland of Keighley, England, relating to the production of double helical gears. The Sunderland machine generates double helical gears from the basic principle, that is, a rack. The teeth are continuous, thus adding to the strength. Being generated by a hardened and ground cutter they are accurate, and consequently the gears give better running results than those formed by other processes. The company predicts that the cost of cutting double helical gears will be considerably reduced and that in the near future double helical gears will be used in all high-class machine tools, etc.

Miscellaneous Advertisements—Situations, Help Wanted, For Sale, etc.

Advertisements in this column, 20 cents a line, seven words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

TEST INDICATORS.—H. A. LOWE, 1374 East Eighty-eighth St., Cleveland, Ohio.

HARDENING, Carbonizing, Galvanizing. C. U. SCOTT, Head of Wall St., Davenport, Iowa.

AGENTS IN EVERY SHOP WANTED to sell my sliding calipers. Liberal commission. ERNST G. SMITH, Columbia, Pa.

SPECIAL MACHINERY AND TOOLS designed and built. CARPENTER DRAFTING CO., 49 Oakland Terrace, Hartford, Conn.

PATENTS SECURED.—C. L. PARKER, Ex-member Examining Corps, U. S. Patent Office. Instructions upon request. 900 G St., N. W., Washington, D. C.

AUTOMATIC AND SPECIAL MACHINES designed. Working drawings. Tracings. Special Tools and Fixtures designed. C. W. PITMAN, 3519 Frankford Ave., Philadelphia, Pa.

GENERAL MACHINERY DESIGNED, working drawings; tracings; patent office drawings; general draughting. Accuracy, prompt attention. SAMUEL GOODMAN, 13 Park Row, New York.

ESTABLISHED SELLING ORGANIZATION, offices, New York, Boston and Philadelphia, solicits correspondence with manufacturers wanting representation. Address Box 611, care MACHINERY, 140 Lafayette St., New York.

WANTED.—POSITION AS FOREMAN or assistant superintendent by an A-1 mechanic; 12 years experience, 4 as foreman, 7 years with present employers. Address Box 615, care MACHINERY, 140 Lafayette St., New York.

AN ESTABLISHED MACHINERY AND SUPPLY HOUSE in the Middle West would like to add to its line one or two specialties of merit for use in machine shops. Address Box 606, care MACHINERY, 140 Lafayette St., New York.

DRAFTSMEN AND MACHINISTS.—American and foreign patents secured promptly; reliable researches made on patentability or validity; twenty years' practice; registered; responsible references. EDWIN GUTHRIE, Corcoran Building, Washington, D. C.

PATENTS.—H. W. T. JENNER, patent attorney and mechanical expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact cost. Send for full information. Trade-marks registered.

WANTED.—A high-grade man to sell metal-working machine tools in the Middle West, preferably a man with a technical education and a good shop training in modern equipment. State experience and give reference. Address Box 621, care MACHINERY, 140 Lafayette St., New York.

FOR SALE.—One 160 HP double tandem horizontal Alberger Gas Engine, 225 RPM, with one direct connected 100 KW Crocker-Wheeler Generator, 3 Phase, 240 Volt, 240 Amperes per terminal. All in first class condition. Address THE AMERICAN MULTIGRAPH CO., East 40th & Kelly Avenue, Cleveland, Ohio.

WANTED.—MECHANICAL ENGINEER as draftsman and superintendent in corporation building special patented machinery in New York. Must be able to invest immediately about $5000, on which a good return is absolutely guaranteed. Others need not apply. Address Box 618, care MACHINERY, 140 Lafayette St., New York.

WANTED.—MACHINIST OR TOOLMAKER as foreman in machine shop in New York, building medium grade and size machines. Must be first-class all around mechanic and be ready to invest immediately from two to five thousand dollars in the business, on which a good return is absolutely guaranteed. No others need apply. Address Box 617, care MACHINERY, 140 Lafayette St., New York.

MEDIUM-WEIGHT MACHINERY BUILT.—We are equipped for the economical building of medium-weight machinery. For companies or individuals interested in making permanent manufacturing arrangements, we will manufacture on a Contract or Royalty or manufacture and market. Proposition must stand rigid investigation. Address Box 619, care MACHINERY, 140 Lafayette St., New York.

WANTED.—DETAIL DRAFTSMAN having experience on large internal combustion and steam engines; must be able to make fine assembly drawings. Also checker with above experience and accustomed to working according to drafting room standards. Location, Middle West. Give age, education, firms, experience and salary. Address Box 622, care MACHINERY, 140 Lafayette St., New York.

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